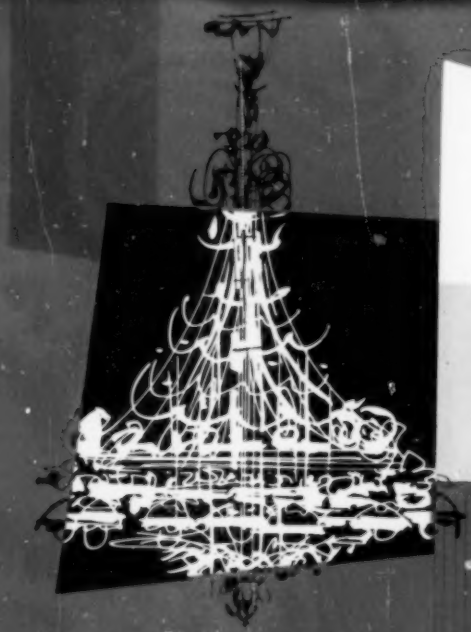

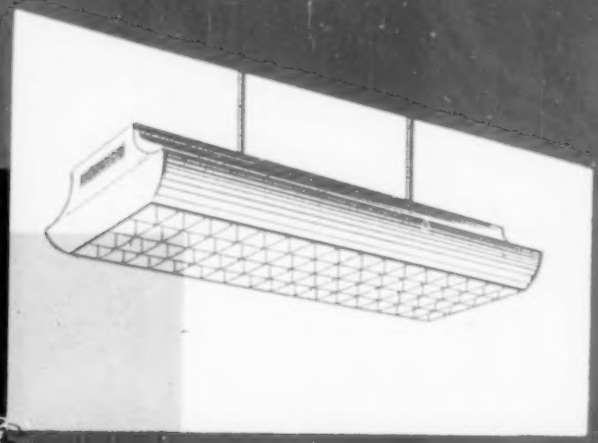

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50th anniversary issue

JANUARY

1956

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

For Lighting . . .
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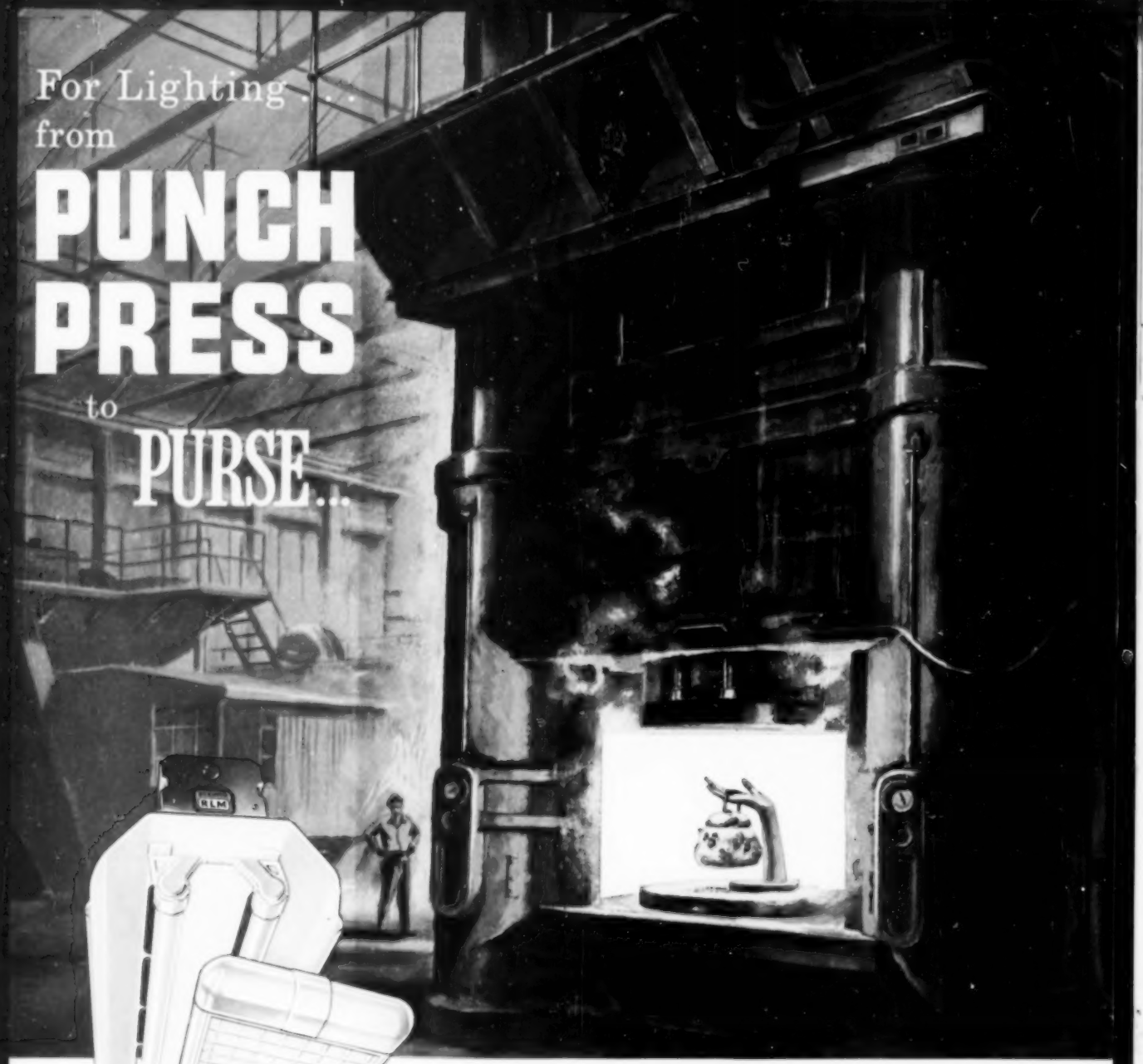
PURSE...



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- **All-White** Porcelain Enamel Reflectors
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- **Shielding Angles** for less lamp glare
- **Latching and Holding** devices for easier reflector maintenance
- **Lampholders**—for easier lamp removal and replacement

R-1229

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The letters RLM stand for Reflector and Lighting Equipment Manufacturers

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Starring **RS-240-260** Ballast

for two 40-Watt Rapid-Start lamps on 240-280-Volt circuits with a nominal rating of 265 Volts.

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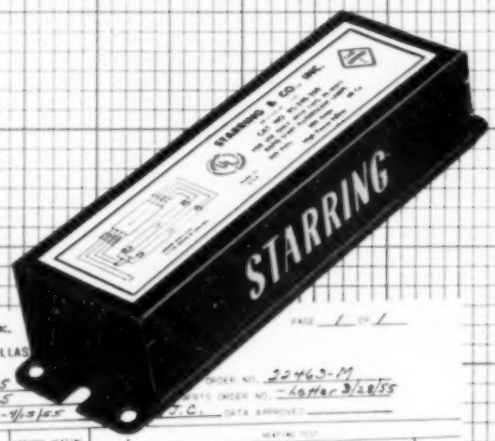

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8⅜" x 2⅛" x 2"
Mounting Length 8⅜"
Weight 5.3 pounds

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

January
1956

Vol. LI, No. 1

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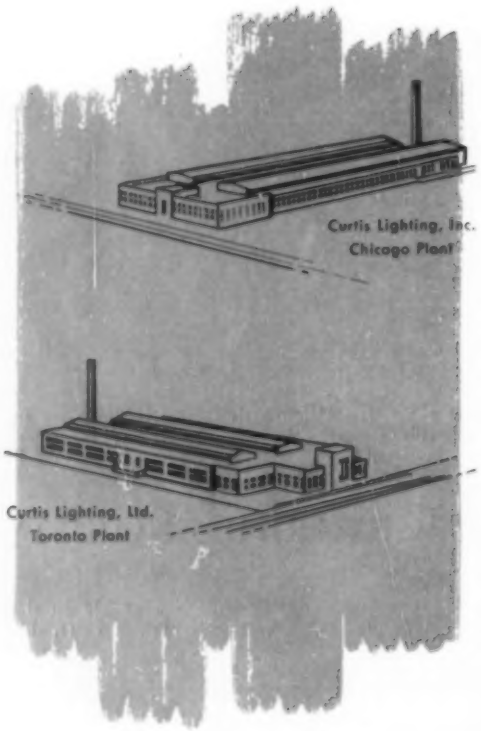
Welcome

CURTIS LIGHTING, INC.

1897-1956



HERE ARE

1897-1907

1 First to develop a one-piece silvered glass reflector for accurate control of light. (The "X-Ray" Reflector — 1897)
2 First to make silvered glass reflector clusters to adapt old gas and electric fixtures for controlled direct lighting.
3 First to incorporate spiral and vertical corrugations in silvered glass reflectors for light diffusing.
4 First to advocate scientific principles in lighting show window displays.
5 First to install a "modern" show window lighting job. (The Washington Shirt Company, Chicago, in 1897)
6 First to use individual silver mirror reflectors for show window lighting.
7 First to export silvered glass reflectors for controlled lighting.

1907-1917

8 First to introduce indirect lighting (Original demonstration made in 1908 before the I. E. S.).
9 First to develop "Adapters" to convert gas and electric stem fixtures to indirect luminaires.
10 First to use portable lamps to provide indirect lighting. (Curtis Adapters)
11 First to emphasize "Eye-Comfort" in lighting applications.
12 First to patent and make indirect luminaires incorporating the luminous bowl principle.
13 First to develop and market a commercial floodlighting projector.
14 First to prepare and distribute "Architectural Plates" on lighting for architects and designers. (1914)
15 First to design church lanterns incorporating concealed reflectors for controlled direct and indirect lighting.

and Congratulations

on Your *Golden Anniversary* for 50 Years of Meritorious Achievement in the Science of Illumination

We congratulate the Illuminating Engineering Society for its outstanding contribution to the progress of lighting since 1906 and welcome it to the Golden Anniversary Group. We offer our sincere thanks to all members for their whole-hearted cooperation and consideration extended Curtis Lighting throughout the years.

On the occasion of our Golden Anniversary we published a series of achievements of our first 50 years and since that time, 1947, we have comparable achievements of which we are equally proud. Now, we would like to re-publish this original list of achievements and add a number more . . . achievements, which, with the fine cooperation of your society, in no small measure have been responsible for Curtis leadership in lighting.

58 CURTIS "FIRSTS" IN 58 YEARS

16 First to develop and apply efficient and controlled cove lighting with individual silver mirror indirect reflectors.
17 First to apply silvered reflectors to pedestal for indirect lighting in foyers, lobbies, public dining rooms, etc.
18 First to develop a specially designed silver mirror reflector for indirect wall brackets.
19 First to use individual silvered glass reflectors for stage lighting.
20 First to develop a show case lighting unit with individual silvered glass reflectors (Scoopette).

1917-1927

21 First to advocate "lighting from concealed sources" as a basic fundamental in lighting practice.
22 First to develop and manufacture a comprehensive line of color equipment for show window reflectors. (Color-Ray)
23 First to manufacture a hospital bed lamp for direct and indirect lighting. (Dua-Light)
24 First lighting fixture company to conduct student courses for training illuminating engineers. (Curtis Lighting Training Group)
25 First to develop the show window floodlight.
26 First to develop a hospital night light with control mechanism for dimming. (Nite Light)
27 First to introduce "color lens" cove lighting for theaters, ballrooms, etc. (Culrlenz)
28 First to incorporate colored indirect lighting in large crystal chandeliers.
29 First to use indirect adapters for candle fixtures.
30 First to develop a "control ring" for show window floodlights.
31 First to use high intensity show window lighting to minimize daylight reflections. (Super lighting)

1927-1937

32 First to design and produce Alzak Aluminum lighting equipment.
33 First to provide equipment to concentrate light on the "Attraction-Zone" in window display.
34 First to apply an automatic control "organ" for spectacular color changes .(Lumitone)
35 First lighting equipment company to be licensed under "Alzak" patents.
36 First to patent and manufacture snap-in cover raceway and a comprehensive line of fittings. (Curti-Strip)
37 First to completely illuminate the exterior surfaces of opaque fixtures by reflected light. ("Edge-Ray")
38 First to manufacture a special library table lighting unit under the Higbee patents.
39 First to make silvered glass reflectors with a patented high temperature heat resisting backing. (The famous Golden Armor)
40 First to make a standard reflector unit for lumiline lamps in continuous lines. (Light-Strip)
41 First with a packaged plug-in show window lighting unit. (Thrifty-Three")

1937-1947

42 First to introduce continuous lines of light for fluorescent lamps. (Fluorescent CurtiStrip in 1938)
43 First with the patented combination reflector lamp shield principle for horizontal shielding of fluorescent lamps. (SkyLux)
44 First commercial lighting fixture company to conduct and organize a training course for the electrical trade on fluorescent lighting.
45 First to develop an "ejector" type socket for fluorescent lamps.
46 First with an "Engineered" four-lamp fluorescent fixture incorporating glass diffusing panels and louvered direct component lighting. (No. 1240 "Firefly")
47 First to develop an asymmetric type reflector for the fluorescent lamp.
48 First to patent and manufacture a low brightness glass bowl fixture for scientific downlighting in stores.
49 First to develop and use a stable white synthetic material for reflecting surfaces. (Fluracite)
50 First to design and manufacture a louvered "low brightness" fluorescent luminaire of Alzak aluminum. ("Forty-Sixty")

1947-1955

51 First to develop low-brightness direct-indirect luminaires for the 60" 40 watt lamps.
52 First to manufacture troffers of Alzak Aluminum for low-brightness lamps.
53 First to develop highly efficient, shielded lamp, fluorescent store lighting luminaires with coefficients of utilization greater than for bare lamps.
54 First to develop a light and sound conditioning system.
55 First to design and manufacture a high-bay Alzak Aluminum housing for mercury vapor and incandescent reflector lamps.
56 First to offer an incandescent downlight with adjustable reflector position for varying spot size. (Vari-Spot Series)
57 First to develop an approved incandescent recessed luminaire to go into a 12" x 12" opening for any type ceiling, with adjustable lamp position for 100 to 300 watts.
58 First to manufacture luminaires for a large area installation of general lighting with high-frequency equipment.

• CHICAGO • TORONTO •

CURTIS LIGHTING, INC.

Library Lighting which Invites Reading and Repose . . .

by LITECONTROL

Even the fine print in a book appears to best advantage in the reading room and stacks at the Roanoke Public Library, Roanoke, Va.

With the high ceiling an important factor to consider, what type of lighting would have maximum efficiency? Litecontrol No. 5828 Recessed Louvered Slimline Troffers, a standard fixture, were "tailor-made" for this application. The reading public, the library staff and the taxpayers were all well served.

If *you* have a lighting problem put it up to Litecontrol. Your local Litecontrol Representative can help you plan the best illumination for the job — and probably save you money in addition.

ARCHITECT: Frantz & Addkison, Roanoke, Virginia

ENGINEER: Wiley & Wilson, Lynchburg, Virginia

FINISHES: Ceiling, Light Buff Tile; Walls, Aquamarine; Floor, Light Tan

CEILING HEIGHT: 18' 0"

FIXTURES: Litecontrol No. 5828 Recessed Louvered Slimline Troffers

SPACING: 9' 0" on centers

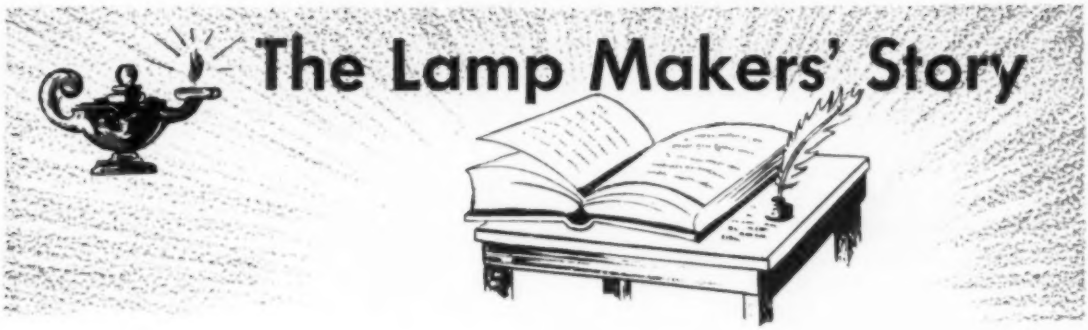
INTENSITY: Average on tables, 40 footcandles in service
Average between stacks, 35 footcandles in service (horizontal plane)

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS



Lamp makers throughout history have been the "Trustees of Light" — each handing down through the ages his concept of lamp design. From the flaming fagot of the cavemen to the candle of colonial times — there was little improvement in the efficiency of these flame sources. Three great eras mark the electrical age — first the development of Edison's carbon filament — then tungsten — then fluorescent—each with improvement in efficiency in the production of light. Present sources have an efficiency 700 times that of the candle.

THE ELECTRICAL industry is one of the few great industries whose initiation and growth are wholly of scientific and engineering origin. The other major industries — agriculture, fishing, mining — and almost all other manufacturing, such as shoemaking, cloth weaving, milling, etc., all had rule of thumb ancestry. There is a sharp division between the electrical industry and this other great class. In the latter, the scientific knowledge and engineering thought that has been given to these industries came long after they matured, whereas the electrical industry has not and possibly never will acquire habits based upon tradition and practice as distinct from scientific thought.

The great electrical industry, with its enormous investments in generating stations, distribution systems, and transmission lines, was developed around and to serve the incandescent electric lamp. From the day when Edison made his basic contribution to the lamp design up to the present, fundamental designs of most incandescent lamps have not changed particularly, although the development of details of this design have been marvelous.

The systems of current distribution, the voltage at which this current should be distributed, the minimum limiting frequency and all other fundamentals of electrical development of today were conditioned upon the characteristics of the incandescent electric lamp; consequently the engineers engaged in this branch of the industry collaborated with the scientists and engineers of the lamp development laboratories at every step.

This has been very favorable to lighting progress in the United States and the present generation can hardly appreciate the part the laboratories of the lamp manufacturers have had in the basic development of the electrical industry.

Had the fluorescent lamp chanced to have been developed at the same time as the carbon filament lamp, it is quite likely that our electrical systems might have developed around totally different voltage and frequency considerations.

It would be entirely misleading to imply that "lighting" was an art born in the technical cradle of the electrical industry. Although we speak of electric lighting as a relatively new industry, we know that artificial light antedates all history; but the scientific and technical thought on illumination has been applied largely in the past 50 years.

Throughout history each family perforce was its own illuminating engineer. Among us still are those who remember candle-moulding techniques, and later on, the daily lighting maintenance task of cleaning lamp chimneys usually assigned to the youngsters of the family. Let's not belabor this nostalgia too much but when the I.E.S. was organized in 1906 — over eight families out of ten in the United States were still using the age-old flame sources. The decorative candle on milady's party table today is a flashback to the lighting art practiced by many generations. Incidentally, the candle still represents a $2.5 million industry and may on holiday occasions pre-empt more counter space in 10c stores than do electric lamps.

The Quarter Century Heritage

Lamp demand had grown through the quarter century to about 40 million a year. The metallized carbon filament had been announced in 1905. New also was the rather complicated Nernst lamp and the air was rife with rumor about new metal filaments — osmium, tantalum, tungsten. All were on the horizon, shortly to be introduced with their business backers. A million or more homes had electricity — one out of ten or so families had electric light. That was the I.E.S. heritage.

Through Fifty Years of Changing Times

Fifty years ago when a few lamp salesmen carried photometers, each to show how much more light his particular brand of lamp gave, when the shrewdest ones were boasting in technical terms of lamp performance and lamp quality, the I.E.S. was organized. Some of the highlights of the next 50 years follow.

Carbon Versus Tungsten

Carbon lamps were top-dog in 1906 when tungsten and tantalum filament lamps appeared on the scene. The chart shows the destinies of each. Tantalum hardly got off the ground — slightly less than a 4 per cent position at best. Tungsten rapidly rose in position as carbon lamps — reaching a peak of 65 million in 1910 tobogganed to less than 10 per cent of demand a dozen years later. While ruled out in 1918 by the War Resources Conservation Board, their manufacture for specialized uses continued for many years in token amounts, sometimes augmented by imports which reached a high of 15 million in 1926.

Voltage Standardization

Carbon lamps could not be made to precise voltage so, as new central stations were set up about the country, individual system voltages were established which ranged from 100 to 130 volts in order to utilize the lamps departing from the center design voltage. With tungsten filament lamps, all could be made for exact voltage. In 1912 when 110 volts was predominant, though representing less than 25 per cent, there began an industry movement for standardization of central station voltages. Even today most people speak of 110 volts to describe present-day distribution circuits, though this voltage is practically out of the picture.

Chart 2 shows what happened and how it stands today when 120 has become the most prominent standard, with 115 volts secondary. This is why today lamps designated for operation for the range

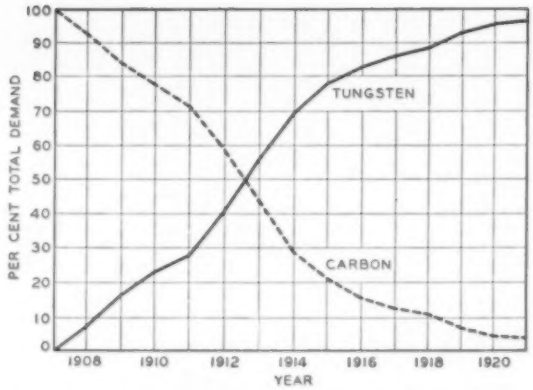


Chart 1. Relative demand for carbon and tungsten filament lamps, 1907-1921. Carbon includes Gem to 1918.

of 115-125 volt circuits often center the design for 118 volts; in which case performance data are based on this intermediate design voltage as the point of reference.

Lamp Wattage Shifts

For purposes of comparison of lamp wattage trends over the years, the percentage is shown for four periods over the past 40 years. These are confined to the common sizes used for general purposes. They do not include lamps for special services such as sign lamps, night lights, railroad, street, etc. As electric rates and lamp prices were reduced, there was a shift to higher wattages and more generous use of light.

It should not be inferred that the average wattage of all filament lamps has increased remarkably through the years. For the first 50 years the average wattage hovered around 50 watts, as tungsten replaced carbon. It has risen by perhaps 30 per cent since, as higher wattages crept up for general applications; however, the applications for low wattage lamps for night lights, signs, indicator and appliances have diluted the overall mixture so that overall "average wattage trends" has little significance.

One must be somewhat tutored in lamp history to explain the ups and downs of the most popular lamp as indicated in Chart 3. For example, the 10-watt lamp was respected for many years as a general utility lamp — today, although thousands of 10-watt and smaller wattage lamps are used for specialized services, they are not generally available in stores: this accounts for the 0% recorded since 1935. Similarly, the 50- and 75-watt lamps when introduced, split the demand two ways. During the war years both the 50- and 75-watt lamps were frowned upon by the War Production authori-

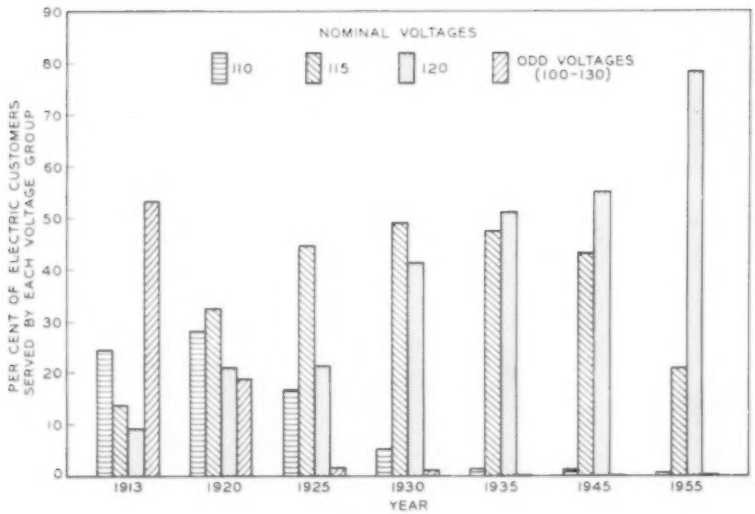


Chart 2.

Normal central station voltage trends, 100- to 130-volt service. Percentage of electric customers served by each voltage group. In the early years it is based on statistics of lamp demand by voltage; in later decades it is based on nominal distribution voltages reported by utilities for the areas they serve. Lamp purchases by voltage do not coincide with these proportions, rather they show that a larger proportion of lamps of higher voltage rating are being used than service voltages call for.

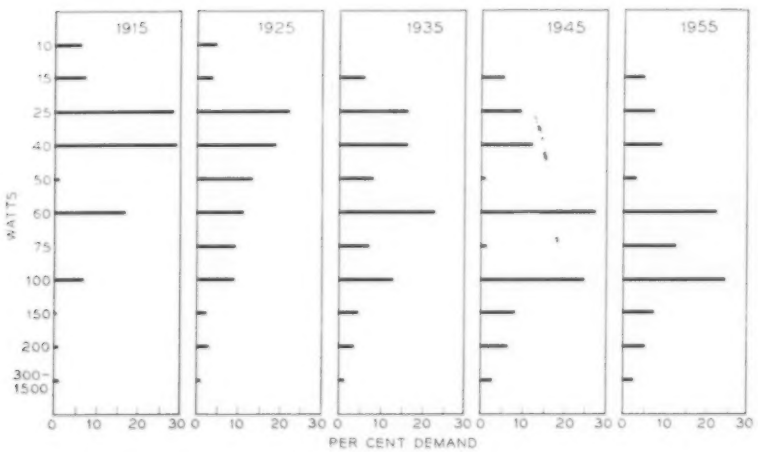
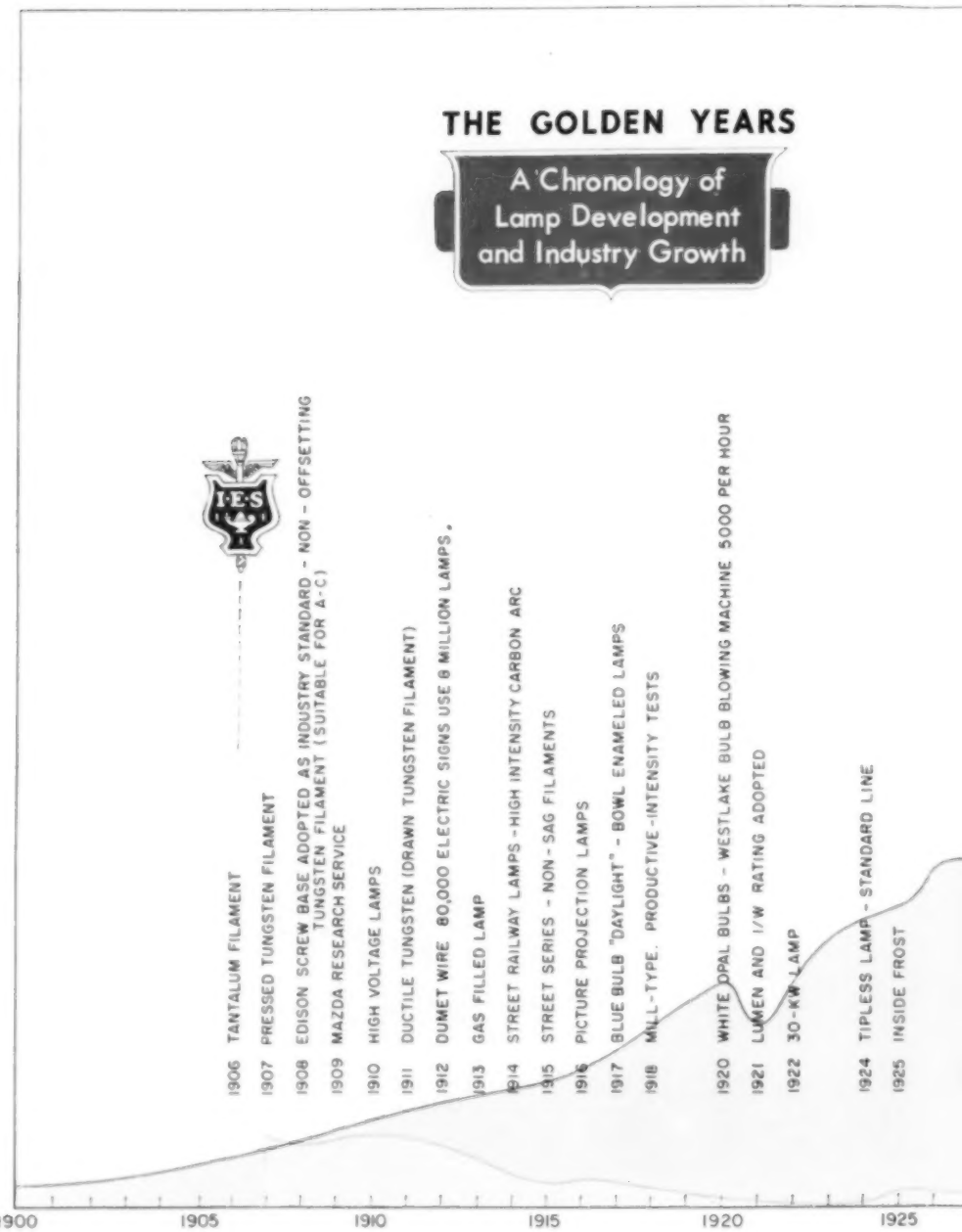


Chart 3.

Wattage trends of filament lamps for general lighting service. Percentage demand by wattage.

THE GOLDEN YEARS

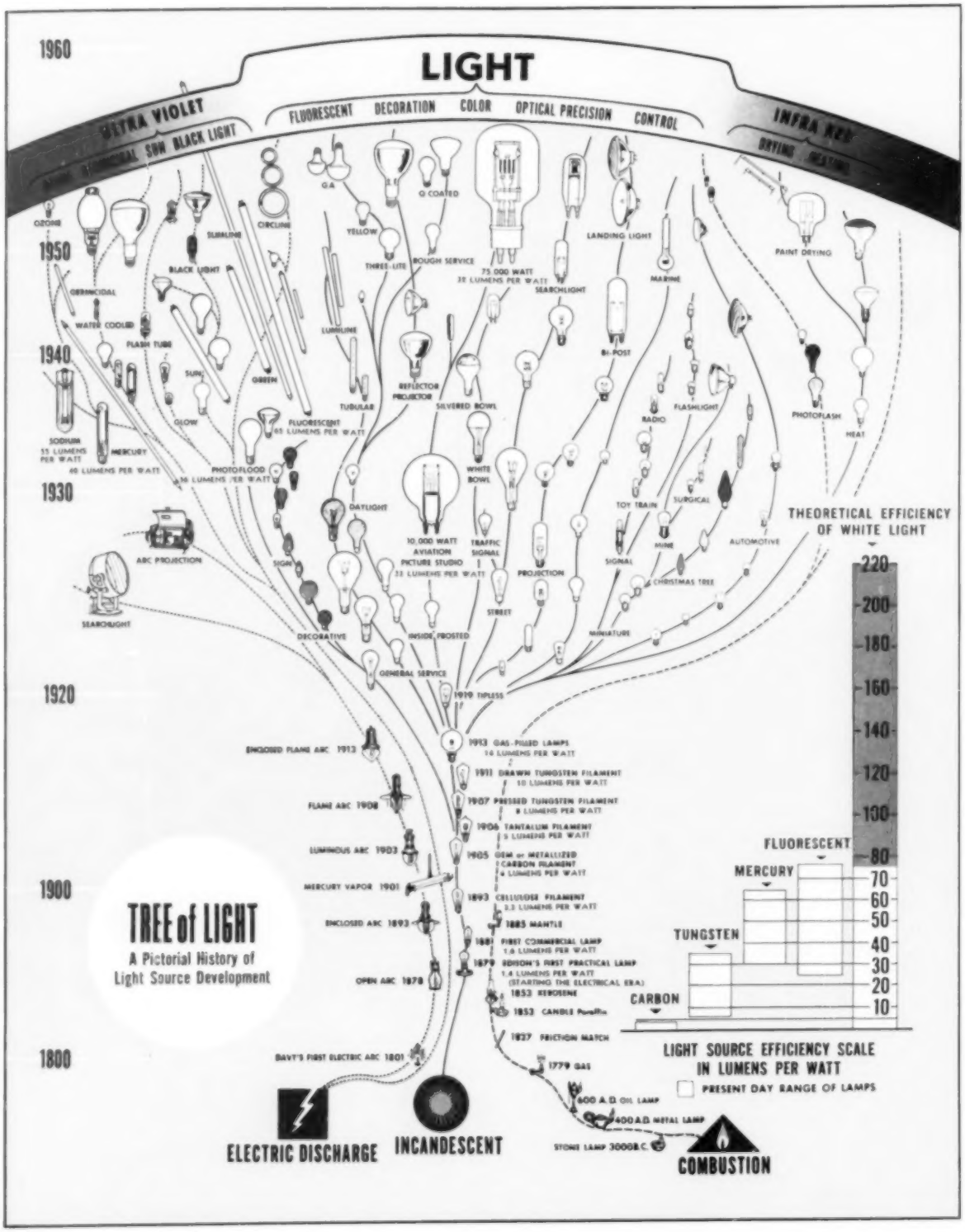
A Chronology of Lamp Development and Industry Growth


1906 TANTALUM FILAMENT
1907 PRESSED TUNGSTEN FILAMENT
1908 EDISON SCREW BASE ADOPTED AS INDUSTRY STANDARD - NON - OFFSETTING TUNGSTEN FILAMENT (SUITABLE FOR A-C)
1909 MAZDA RESEARCH SERVICE
1910 HIGH VOLTAGE LAMPS
1911 DUCTILE TUNGSTEN (DRAWN TUNGSTEN FILAMENT)
1912 DUMET WIRE 80,000 ELECTRIC SIGNS USE 8 MILLION LAMPS.
1913 GAS FILLED LAMP
1914 STREET RAILWAY LAMPS - HIGH INTENSITY CARBON ARC
1915 STREET SERIES - NON - SAG FILAMENTS
1916 PICTURE PROJECTION LAMPS
1917 BLUE BULB "DAYLIGHT" - BOWL ENAMELED LAMPS
1918 MILL-TYPE. PRODUCTIVE-INTENSITY TESTS
1920 WHITE OPAL BULBS - WESTLAKE BULB BLOWING MACHINE 5000 PER HOUR
1921 LUMEN AND I/W RATING ADOPTED
1922 30-KW LAMP
1924 TIPLESS LAMP - STANDARD LINE
1925 INSIDE FROST
1900
1905
1910
1915
1920
1925

LAMP DEMAND (MILLIONS)	38	80	116	205	279
U.S. POPULATION (MILLIONS)	84	92	100	105	116
LAMPS PER CAPITA	0.45	0.87	1.2	2.0	2.4
ELECTRIFIED HOMES (MILLIONS)	1.25	3.10	5.80	8.70	15.0
LAMPS PER ELECTRIFIED HOME	30	26	20	24	18.6
LAMP HOURS CONSUMED (TRILLIONS)	4.52	14.1	44.5	112	197
LUMEN HRS. PER CAPITA (MILLIONS)	0.054	0.153	0.445	1.06	1.61
LUMEN HRS. PER ELECTRIFIED HOME	3.6	4.55	7.67	12.9	13.1
LUMEN HRS. PER LAMP (MILLIONS)	0.119	0.176	0.384	0.546	0.706
AVG. LAMP PRICES-ALL TYPES-MFGRS. NET	20¢	23¢	22¢	22¢	22¢
AVG. COST OF LIGHT PER MILLION LUMEN HRS.	$37.16	$20.56	$8.30	$6.94	$5.11

1924 TIPLESS LAMP - STANDARD LINE
1925 INSIDE FROST
1927 RIBBON BULB MACHINE, 50,000 PER HOUR - 1000 WATT AIRWAY BEACON LAMP
1928 NEON SIGNS IN U.S. ROUGH SERVICE LAMP - GLOW LAMP - PREFOCUS BASE - DIVING LAMP
1929 LIGHTS GOLDEN JUBILEE - SUNLAMP - AVIATION LAMPS
1930 PHOTOFLASH - INSIDE COLORED INCANDESCENT LAMP
1931 3 WATT LAMP - BI-PLANE FILAMENT PROJECTOR LAMP
1932 PHOTOFLOOD
1933 SODIUM VAPOR LAMPS - TWO-FILAMENT THREE-LITE LAMPS - GERMICIDAL LAMP - BI-POST BASE - PREFOCUSED AUTOMOBILE HEADLIGHT LAMP
1934 MERCURY VAPOR LAMPS - TYPE H
1935 SILVERED BOWL - 60 WATT COILED COILED - COLD CATHODE - LUMILINE INCANDESCENT
1936 FLUORESCENT PHOSPHORS
1937 PAR SEALED BEAM AUTOMOBILE HEADLAMP (LABORATORY -- FIRST INTRODUCED ON 1940 AUTOS)
1938 FLUORESCENT 15, 20, 30 WATT - REFLECTOR MERCURY - PAR AND R LAMPS (PROJECTOR AND REFLECTOR LAMPS) - 1000 WATT H-6 MERCURY - XENON FLASHBOTIES
1939 40 WATT FLUORESCENT - GLOW SWITCH - SILENT ARC MERCURY
1941 INFRARED LAMPS - 3KW MERCURY - BLACK LIGHT FLUORESCENT - RS SUNLAMP - 250 WATT QUARTZ
WAR YEARS 400 SPECIALIZED LAMP DESIGNS FOR THE ARMED FORCES
1944 SLIMLINE LAMPS - INSTANT START FLUORESCENT - ANTI-HUMIDITY TREATMENT
1945 CIRCLINE FLUORESCENT LAMP
1946 FLUORESCENT SUNLAMP
1948 SILICA DIFFUSING COATING
1949 OZONE LAMP - HIGH BAY REFLECTOR LAMPS - COLOR CORRECTED MERCURY - SILICA COATED INCANDESCENT
1950 ELECTROLUMINESCENCE
1953 RAPID START FLUORESCENT
1954 QUARTZ INFRARED -- 500 TO 5000 WATTS, NOISE-FREE PHOTO LAMPS
1955 HIGH-OUTPUT FLUORESCENT
LAMP DEMAND IN MILLIONS
0
100
200
300
400
500
600
700
800
900
1000
1100
1925
1930
1935
1940
1945
1950
1955

279	351	413	594	800	1024	1110
116	123	127	132	140	152	165
2.4	2.9	3.3	4.5	5.7	6.7	6.7
15.0	20.0	21.0	25.6	29.4	39.1	44.4
18.6	18.0	19.7	23.2	27.6	26.2	25.0
197	282	316	556	1145	2245	2550
1.61	2.29	2.49	4.21	8.18	14.8	15.5
13.1	14.1	15.5	21.7	39.0	57.4	57.5
0.706	0.806	0.765	0.936	1.431	2.192	2.297
22¢	18¢	13¢	11.5¢	14¢	16.8¢	20.2¢
$5.11	$3.84	$2.90	$1.92	$1.36	$1.19	$1.20


LIGHT
ULTRA VIOLET
FLUORESCENT
DECORATION
COLOR
OPTICAL PRECISION
CONTROL
INFRA RED
1960
1950
1940
1930
1920
1900
1800
OZONE
GERMICIDAL
WATER COOLED
FLASH TUBE
SODIUM
55 LUMENS PER WATT
MERCURY
60 LUMENS PER WATT
BLACK LIGHT
SUNLAMP
GLOW
SUN
GREEN
CIRCLINE
PHOTOFLOOD
36 LUMENS PER WATT
FLUORESCENT
65 LUMENS PER WATT
TUBULAR
LUMILINE
YELLOW
THREE-LITE
GA
Q COATED
ROUGH SERVICE
REFLECTOR PROJECTOR
SILVERED BOWL
WHITE BOWL
DAYLIGHT
10,000 WATT AVIATION PICTURE STUDIO
22 LUMENS PER WATT
TRAFFIC SIGNAL
STREET
PROJECTION
INSIDE FROSTED
DECORATIVE
GENERAL SERVICE
SIGN
ARC PROJECTION
SEARCHLIGHT
75,000 WATT
30 LUMENS PER WATT
SEARCHLIGHT
LANDING LIGHT
MARINE
BI-POST
RADIO
FLASHLIGHT
TOY TRAIN
SURGICAL
MINE
SIGNAL
CHRISTMAS TREE
AUTOMOTIVE
MINIATURE
PAINT DRYING
PHOTOFLASH
HEAT
1919 TIPLESS
1913 GAS-FILLED LAMPS
10 LUMENS PER WATT
1911 DRAWN TUNGSTEN FILAMENT
10 LUMENS PER WATT
1907 PRESSED TUNGSTEN FILAMENT
8 LUMENS PER WATT
1906 TANTALUM FILAMENT
5 LUMENS PER WATT
1905 OSM or METALLIZED CARBON FILAMENT
4 LUMENS PER WATT
1893 CELLULOID FILAMENT
2.5 LUMENS PER WATT
1885 MANTLE
1881 FIRST COMMERCIAL LAMP
1.8 LUMENS PER WATT
1879 EDISON'S FIRST PRACTICAL LAMP
1.4 LUMENS PER WATT
(STARTING THE ELECTRICAL ERA)
1853 KEROSENE
1853 CANDLE Paraffin
1827 FRICTION MATCH
1779 GAS
600 A.D. OIL LAMP
400 A.D. METAL LAMP
STONE LAMP 3000 B.C.
ENCLOSED FLAME ARC 1913
FLAME ARC 1908
LUMINOUS ARC 1903
MERCURY VAPOR 1901
ENCLOSED ARC 1893
OPEN ARC 1878
DAVY'S FIRST ELECTRIC ARC 1801
TREE of LIGHT
A Pictorial History of Light Source Development
ELECTRIC DISCHARGE
INCANDESCENT
COMBUSTION
THEORETICAL EFFICIENCY OF WHITE LIGHT
220
200
180
160
140
120
100
80
70
60
50
40
30
20
10
FLUORESCENT
MERCURY
TUNGSTEN
CARBON
LIGHT SOURCE EFFICIENCY SCALE
IN LUMENS PER WATT
PRESENT DAY RANGE OF LAMPS

ties as non-essential. The effect of this ruling shows up in the latest demand figures. Today the 100-watt size is out in front. Above 100 watts the higher wattage lamps showed considerable gains throughout the years — but are now losing position as fluorescent pre-empts many of the general lighting applications in commercial and industrial lighting.

The Golden Years Chart

Except for researchers seeking intimate lamp development details, the chronology chart perhaps will be of interest to most readers for its historical generalities. Nobody can do anything about it now, but it may be stimulating to think how this chart might look extended another 25 years. Many thousands of people have had a hand in the developments listed. Hundreds of scientists and development engineers have participated — thousands of employees in the lamp factories have in the past 50 years made over 40 billion lamps. Thousands of others, many of them I.E.S. members, have guided the use of lamps into hundreds of varied lamp applications.

A few brief comments about the chart may be in order. First, the lamp demand curve applies only to "large" lamps — it does not include miniature or photoflash lamps. Other than fluorescent, shown separately, the overall curve includes not only filament lamps but also mercury and other electric discharge lamps of all types which in the billion lamp total are insignificant chartwise. Data are not available to take into account the hundreds, maybe thousands, of miles of "neon" sign tubing that have been produced over the years.

Lamps per Capita has little significance in the early years but becomes an index of usage in later years and from here on, particularly, when everyone has electric light at his command.

Lamps per Electrified Home is more meaningful, but it does not mean lamps used in the home. In the early days of course, industrial and commercial electrification was out of proportion to home electrification; so the lamp demand shows a high of 30 in 1905 — decreasing to 17 in 1930 and increasing from there because in the late twenties a million and a half homes were being wired for electricity each year.

The figures become more significant later on, and especially in the last few years. Now practically every home and almost every occupied building have electric light.

From here on at least this might become a fair index, because as population grows, new households are established, and new industries, schools, stores and commercial buildings are built to keep apace. The overall statistics will help polish at least one significant facet of progress.

Lumen hours consumed are measured in trillions (thousands of billions, that is). Again "Per capita" and "per Electrified Home" consumption haven't too much significance in earlier years, except to point out that the public accepted the triple light output of the tungsten lamp over the carbon. In later years, it shows that they are accepting the triple efficiency of the fluorescent lamp over tungsten lamps for a great many applications. This statistic indicates primarily that "mere light" is not enough to satisfy human instincts. If the price is right they will buy more light.

Lamp Price and Cost of Light go together. The decreasing cost of electric current over the years, however, is the most important factor in the cost of light. The cost of lamps has averaged around 10 per cent of the cost of current to burn them out. This ratio has long prevailed — give or take a couple of points one way or another as far as specific users are concerned.

By the time the I.E.S. was organized in 1906 the average cost per million lumen hours had decreased from over $70 to $37.16. Today it averages less than a dollar at average lamp prices and average kilowatt-hour rates for all services.

Lumen Hours per Electrified Home and Lumen Hours per Lamp are somewhat of the same measure. Both show the increased acceptance of higher

Tree of Light

Edison started this tree from the seed of a single electric lamp and a single customer. In May 1880 the new steamship *Columbia* lighted by 115 carbon filament electric lamps — created a sensation on her first voyage from New York to San Francisco. Next year, the first commercial installation on land was in a New York lithographer's shop — using 60 lamps.

Today — in the catalogs of lamp manufacturers you will find listings of over 3000 lamps of specific design (this multiplies up to 20 or 30 thousand, if you consider variations in voltages, bases and bulb finishes) to serve the needs of 50 million or more customers on land, sea and air — and under land and under sea.

The several types of fluorescent lamps introduced in 1938 have today grown to over 300 types of various lengths, colors, and operational characteristics.

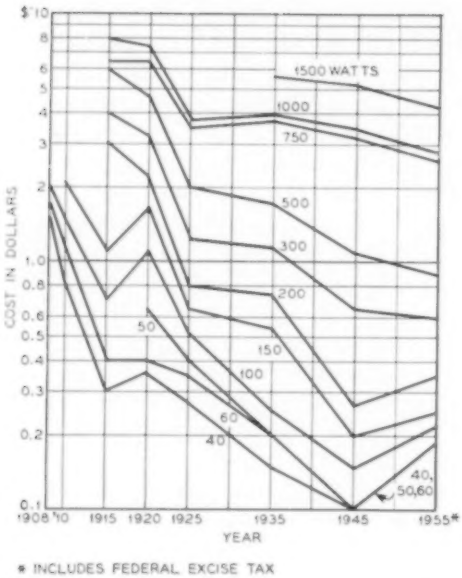


Chart 4. Chronology of general service lamp prices.

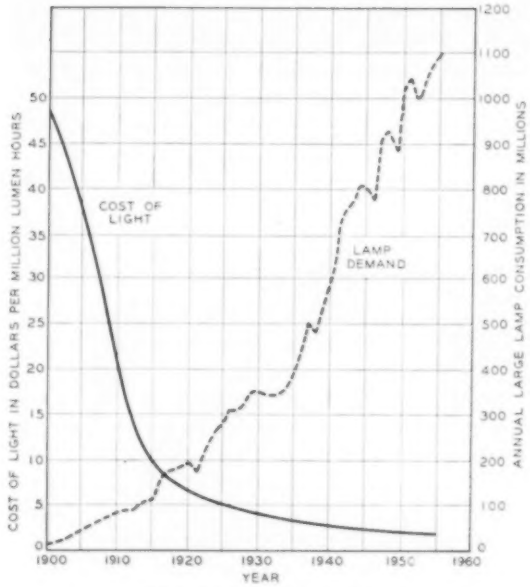


Chart 5. The cost of light.

lighting standards through the years, not specifically in homes, but by all users of electric light. The data include lamps used in all fields of application. Electrified homes is merely an index as mentioned before. In compilations since the fluorescent lamp came into the picture, the computations become a matter of studied estimates, because the "Lumen Hours" inherent in a fluorescent lamp involves the question of lamp life and lumen output under specific conditions of installation; the lumen output of slimline fluorescent lamps for example, is definitely related to the operating current provided by the ballast ratings. Then, too, the lumen-hour life averages may deviate considerably from the nominal life ratings which are based on a prescribed number of burning hours per start. Nobody quite knows what the latter might be. Best figuring yields data shown in the large chart. Chart 5 shows the Cost of Light per million lumen hours. This does not pretend, however, that "lumen-hours" alone is a measure of lamp progress and satisfaction. The comfort of a flashlight in the dark is worth the cost of current of $1.00 or more per kw-hr. That is why lamp economics defy agreeable comparisons as far as usage in specialized fields is concerned. There are too many factors that just don't yield to engineering analysis in a precise statistical chart. We give up when it comes to figuring the lumen-hours of the millions of candles that are sold each year. Yet who is there who would trade the candles on his birthday cake for statistics on lumen-hours generated, even though his smokey lumens may cost a hundred times more than clean electrical lumens?

The Fluorescent Lamp

On April 1, 1938, the fluorescent lamp was introduced in lamp catalogs in 15-, 20- and 30-watt sizes. At that time, the most intriguing thing was the

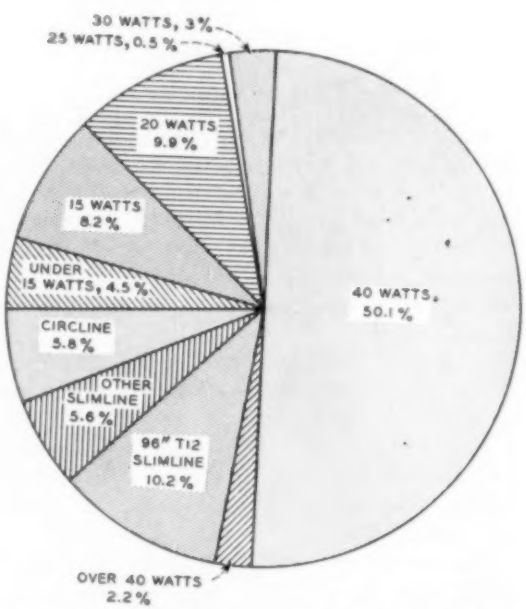


Chart 6. Fluorescent lamp demand by size, 1955 (estimated, based on eight months).

efficiency with which colored light could be generated and the advertising of the day stressed that green light could be produced at 200 times the efficiency of filament lamps with filters. Other colors gave other astonishing efficiencies. Lamps were listed in blue, green, pink gold and red colors, including "daylight" and white. Enthusiasm was rampant for a new era in the use of colored light; few at that time visualized the impact that fluorescent lamps were destined to make in lighting practice as we know it today.

Both interesting and informative, are the two accompanying charts which show how the fluorescent lamp demand splits up as this is published. First is a chart showing the relative demand by size and type of lamp. The second chart shows the relative demand by the various "white" lamps in the three largest demand sizes.

Colored lamps which in 1938 seemed to give major significance to the fluorescent lamp, are presently only a one per cent factor in the market.

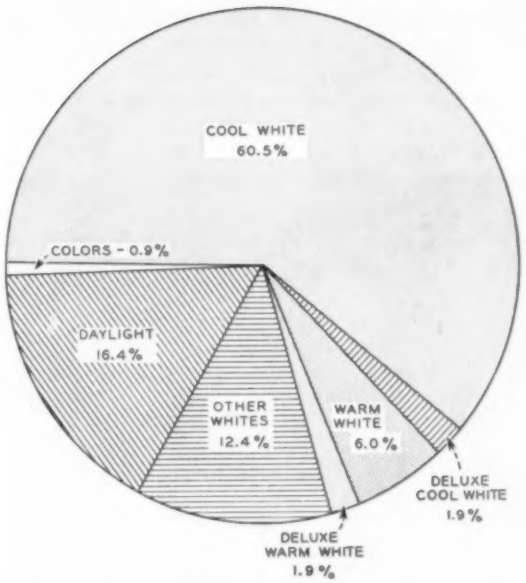


Chart 7. Fluorescent lamp demand by color distribution, 1955 (estimated, based on eight months).

Miniature Lamps

(excluding types used for automobiles and airplanes)

Uses for very small light sources began to develop shortly before the turn of the century, when the electric lamp was nearly 20 years old. Decorative applications were among the first. However, it was another contemporary invention, the telephone, which offered the initial significant commercial use of miniature lamps. Mechanical signals on the early telephone switchboards were unequal to the needs of the growing communicatioin industry. When switchboards were redesigned, tiny carbon lamps provided the element which simplified and modernized operations. More than a half century later, virtually the same type miniature lamps are still the standard for telephone switchboards.

The application for communications was prophetic. The rush of inventions through the early years of the 20th century have led to combinations in machine and instrument design progressively integrating whole series of processes. Automation, which is a word to conjure with today, implies equipment capable of performing a complex sequence of manufacturing operations by machines without the intervention of a human being. Of course, some one must watch the dials while products in progress speed through automation machines. The nerve system of the equipment communicates with its human sponsors on illuminated dials and by means of luminous signals. Thus, successive stages of operation, and warnings when necessary are reported visually to observers. Miniature lamps provide the element which links the quasi-human automation equipment with its managers.

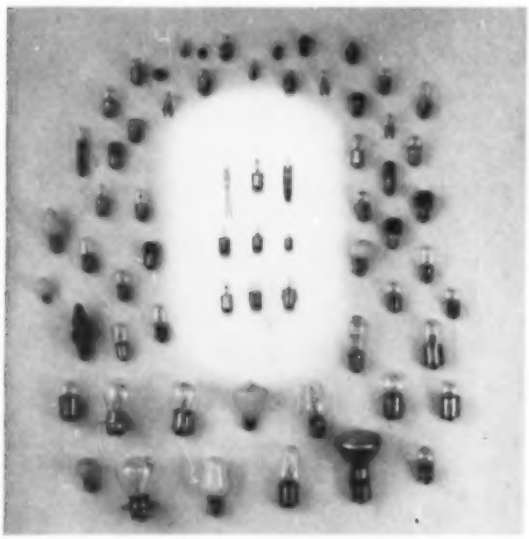
Long before automatic processes had acquired the prominence they have today, miniature lamps had been performing vital services for industry and commerce. In mining, for instance, the introduction of battery operated cap lamps was a tremendous advance in safety practice. It seems hard to believe that until quite recent times miners worked with the hazard of flame sources.

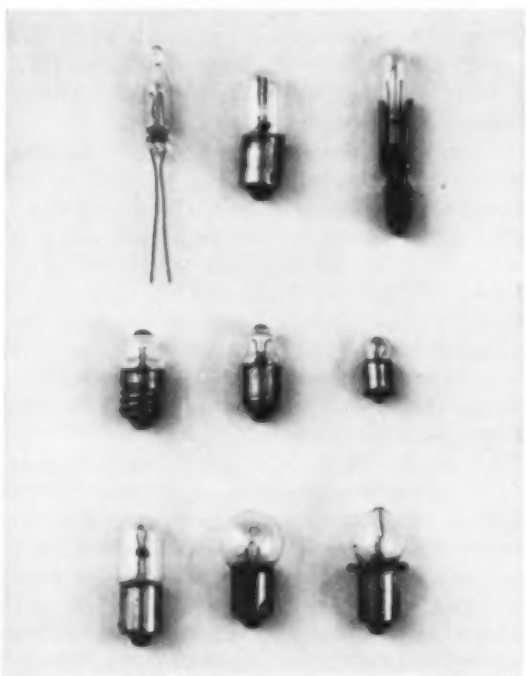
Surgeons and scientists, mechanics and farmers have greatly extended the scope of their undertakings with the aid of miniature lamps. Difficult or impossible operations have been made safe and routine with the aid of light from very small sources. Likewise, the laboratory has been able to afford the research scientist with the tools for looking into ultra-small phenomena. Then the wide range of inspection methods employed in industry has depended upon little lamps to throw light onto hard-to-see areas.

Farmers have long since replaced the hazardous and bulky oil lantern with flashlights, and electric lanterns. What farm people have learned of the convenience and protection provided by flashlights, many others know in their own fields of experience. Policemen and doctors, truck drivers and railroaders carry them as professional equipment. The motorist, and that includes most of us, has his own

categories of emergency in which flashlights are the most important first aid.

Household devices equipped with miniature lamps have vastly improved the comforts of home since the I.E.S. was founded. Nightlamps and switchplate indicators add safety and confidence. Illuminated house-numbers, key chain flashlights, or vacuum cleaner headlamps, waffle and hand iron signals, and the array of indicators on ranges and radios have become part and parcel of the way homelife is influenced by conveniences.





Some representative types (above) of miniature lamps, which come in many sizes and shapes. Some of the more widely used lamps (below) are, left to right: Top row, NE-2 glow lamp; NE-51 glow lamp; telephone switchboard lamp; Center row, No. 112 flashlight (penlight); No. 224 flashlight (penlight); No. 327 aircraft instrument lamp. Bottom row, radio panel light; No. 55 auto lamp; PR prefocus flashlight.

The task of the engineer designing equipment employing miniature lamps is in a different realm from his brother who studies techniques employing large lamps and large areas. The world of the little light source is less spectacular, but at work or at home and in the air or on the sea, no less than on the land, we depend upon miniature lamps to serve us in a thousand ways.

There are, today, three general types of miniature lamps, each distinguished by a particular seal. There are flange seal, butt seal and pinch seal lamps.

Flange seal lamps are suitable for higher currents with ratings up to 12 amperes practical. The plane of the filament is generally in the plane of the lead wires. When these lamps are made with bayonet bases the plane of the filament and the lead wires is normally at right angles to the plane of the base pin, though no close limit applies.

Since a large percentage of miniature lamps is used in optical systems employing either parabolic reflectors or reflector-lens equipment in most cases, very concentrated filaments are required. Such filaments provide for better control or redirection of the light. In some equipment light is built up in a narrow beam 1000 times stronger in the brightest part than light from the bare lamp alone. Precision of this order requires the filament location within a few thousandths of an inch of the focal point of the reflector.

Butt Seal Lamps are widely used. Telephone switchboards, aircraft control panels, flashlights, clocks, radios and coin machines are equipped with them. Of the immense variety of inspection tools, most employ this type of miniature lamp.

In making these lamps a mount consisting of lead-in wires, bead, filament, and sometimes anchors, is dropped into the open end of the bulb. To locate the filament at the desired distance from the end of the bulb the lead-in wires are bent to provide just this length. Then an exhaust tube is dropped down and butted against the lead wire and glass bulb. Flames then seal the parts together. The seal is fragile. It is protected when the base and cement are applied. Butt seal lamps are generally limited to about .8 ampere.

Pinch seal lamps are made by a very old process. The small neon glow lamps are made with this seal. A recent indicator lamp is also made with a pinch

seal, but the exhaust type is at the bottom rather than the top of the lamp. Thus, in most lamps of this type, lead-in wires are sealed and *pinched* in the glass at one end of the tubular bulb which is exhausted and tipped off at the top.

Glow lamps have a critical "breakdown" or starting voltage. Like all electric discharge lamps they have a "runaway" characteristic and must be operated in series with a current limiting device such as a resistor. Color lamps make excellent live-circuit indicators since they are so small, and operate so cheaply. These lamps are used also as voltage regulators, subject to the limitations of maintaining voltage and safe current values. The critical starting voltage of these lamps makes possible their use in a flashing or oscillating circuit of the relaxation type.

Since glow lamps give visual indication of currents as low as one microampere, they may be used as indicators of very high resistance short circuits or extremely small leakages. Use of these lamps in counters and computers is increasing in recognition of their special characteristics. Thus the promise of some of the widely heralded instruments of automation is, in significant part, supported by a miniature lamp. Here, again as in so many better known applications, miniature lamps are making history in inverse proportion to their size.

Miniature Lamps — History

One of the early references on miniature incandescent lamps is Bulletin No. 8, December 14, 1908. prepared by the Engineering Department of the National Electric Lamp Association. It contains a complete list of the regular types of miniature and candelabra carbon lamps for decorative service, battery inspection, automobile, telephone and special services available in 1908. Page 19 of this book describes the festoon style lamp, a 3-candlepower lamp of 12- to 16- volt rating. The novelty battery lamps (from page 29 of the Bulletin) were especially designed to burn on dry batteries. They were used for such services as portable lights, lighting novelties, bicycle lamps, portable electric candle sticks, electric clock lights, electric pocket searchlights, etc. Most of these lamps were equipped with miniature screw bases though one was smaller and equipped with a base described as midget. An interesting novelty was a "scarf pin lamp." Additional battery style lamps for dental and surgical use were also shown. The smallest lamp was identified as a cystoscope or "Grain of wheat" lamp. The bulb was about ⅛" in diameter and 7.16" long. Various bases used on early telephone switchboard lamps follow from the next page of the 1908 Bulletin. The lamps were available in voltages ranging from 4 to 50 volts and with the variety of bases shown. It will, therefore, be noted how the early original design has influenced lamp manufacture for 50 years. Other early lamps described include gun sight and range finder lamps, Navy style instrument lamps for Cory and Fiske instruments as well as a "torpedo" lamp with wires attached for inspection service.

A succeeding bulletin, 8A, August 15, 1909, discusses tungsten filament miniature and low voltage lamps. Tungsten miniature lamps were classified according to the service for which they were designed. Three classes were used, (1) general battery service, (2) novelty battery service, (3) dental, optical and surgical battery service. General battery service included lamps from 4 to 10 volts operating at an efficiency of 1 to 1.25 wpc. Some of these were classified as automobile headlights, side lights and taillights. Other general battery type lamps were built in P-6½, T-8, T-9 and P-12 bulbs as well as G-10. Tungsten novelty battery service lamps from 1.5 to 5.5 volts came equipped with candelabra bases and were intended primarily for dry battery use. The tungsten lamps were three to six times as efficient as the carbon novelty lamps. Novelty lamps with miniature bases were made with flat end bulbs, G-3½, G-4½, G-5½ and G-6 bulbs and designed for 1-, 2-, 3- and 5-cell operation as well as from a single cell storage battery. G-4½ lamps were shown with end tips while the G-3½ lamps were illustrated with side tips. Again the dental, optical and surgical lamps from 2.5 to 5.5 volts operating at an efficiency of approximately .9 to 1 wpc were generally supplied unbased for connection to the instrument or special holder.

When specially ordered, tungsten miniature lamps could be supplied in natural colors: green, blue, purple and ruby, or in "superficial" colors: green, blue, purple, ruby, opal, amber and yellow. Miniature lamps were also made with frosted bulbs.

George W. Vinal, in his book, "Primary Batteries" reports that Gasner is credited with producing the first successful dry battery, about 1888. Another form of primary battery was modified and improved by Edison in 1889. The best known form of it in use today is in the railway signal type of primary battery. While the production of dry cells, such as the 6-inch or No. 6 cell started about 1890, it was not until 1900 that the miniature or flashlight type of cell was made. According to Cedar and Meade it was in 1900 that the first carbon filament flashlight lamp was made. The first flashlight cells were made in a variety of sizes and were grouped in 2- and 3-cell combinations for which service 2.3-, 2.5 and 3.8-volt lamps were designed.

Cedar and Meade say: "Neither the carbon filament flashlight lamp nor the primary battery for flashlight service made very much headway until 1910. At this date greater use of flashlights was stimulated by the invention of the more efficient tungsten filament lamp as well as by rapid advances that have been made in the development of the dry cell. The total production of dry cells in 1909 was 34 million cells; total domestic production of miniature lamps for 1909 was about 2 million. The tungsten filament for flashlights at that time resulted in an efficiency improvement of about 400 per cent over the carbon filament."

The Bureau of Mines tests (about 1913) indicated that some bulbs used for miners' cap and hand lamps would be certain to ignite gas when broken. A desirable safety feature for the design of mine lamps became an automatic break in the electrical circuit to the bulb when the glass lens is broken. This objective influenced tests on a broad range. Doorbell transformers with miniature lamps were tested but toy transformers provided a more satisfactory solution for the safety problem. The Ceag Electric Safety lamp of foreign manufacture was the first portable electric mine hand lamp approved by the Bureau of Mines as permissible for use in mines with known gas hazards.

The demand for carbon and tungsten filament miniature lamps for 1913 was estimated at approximately 20 million including all types, such as flashlight, automobile, decorative, Christmas tree. About one-half of this volume was in flashlight lamps, and of the remaining most were in automobile types.

Ten years later, in 1923, according to Porter, 174 million miniature incandescent lamps were sold. Of these the breakdown went about as follows: 60 per cent for auto service, 20 per cent for flashlight, 17 per cent for Christmas tree decorations, and the remaining 3 per cent for miscellaneous use such as surgical and dental, signal outfits, U. S. Lighthouse service, highway crossing beacons, small motion picture projectors, miner's cap lamps, motor boat lighting, gauge lamps, searchlights, switchboard indicator lamps, etc. The most popular lamps for Christmas tree service were those designed to be burned eight in series on regular house lighting circuits of 110- to 125-volt class or in the multiple on transformers connected to such circuits. Lamps of lower voltage were made for multiple burning on dry cells or storage batteries. These Christmas tree lamps were made in a variety of colors as well as fancy shapes, though the most popular lamp was designated a C-6 bulb. Dental and surgical lamps, while of small volume constituted approximately 100 different varieties. There was little standardization in that field then and not much more now.

About 1926 or '27, electric highway beacons began to compete seriously with gas operated beacons. An ingenious lamp-changing mechanism, developed by Wallace, automatically replaced a burned out lamp. This gave an opportunity of designing the equipment to utilize ten or a dozen lamps, over-voltaging them slightly for greater brilliance instead of under-voltaging them for prolonging lamp life as had been previously necessary. As the miniature lamps were low in price the result obtained justified the additional cost of the extra lamps. A flasher thus installed with six No. 6 cells had a six month's supply of batteries and lamps. The development of the automatic lamp changing, soon rapidly extended the use of miniature lamps to marine service.

Radio panel lamps were first developed in 1925. They were used on three of the 500 different makes then on the market. About 80,000 radio panel lamps were used the first year, 360,000 in 1926, 1.4 million in 1927 and 8 million in 1929.

In the early Thirties, penlight lamps with built-in lenses were introduced. It is believed the first such lamp came from Japan. Improved lens-end lamps described as TL-3 bulb lamps were introduced early in 1936.

Due to the demand for more perfect flashlight spots, the prefocused types of lamps, No. PR2 and PR3, were introduced in March of 1937. The latter part of December '53, saw the introduction of PR-14, a prefocused lamp having a concentrated filament and a second spread filament to produce a beam. December of '54 saw the introduction of a radical new type of lamp, a lamp without conventional base but with two sturdy pins for support and connection.

Most glow lamps are miniature in size, light output and wattage consumption. Glow lamps were originally patented in Holland and made available there in 1919 in high voltage. D. McFarland Moore worked on them at Harrison in 1919 and made an experimental 120-volt lamp. They were first sold in 1924. They were transferred to the General Electric Vapor Lamp Co. in 1925. Foulke made the first 120-volt d-c lamp shortly thereafter. The shipments in 1927 totalled about 1000. In September of 1925, Moore and Porter presented a paper to the Annual Convention of the Illuminating Engineering Society on the lamps Moore had developed and their possible applications. These are shown, respectively, on page 176 and 186, Vol. 21, 1926, July issue of the Transactions.

Throughout the years the tool of the Lighting Art has been EQUIPMENT

The implements of the Lighting Art, aside from light sources, as such, comprise a vast array of miscellaneous devices. All of these have had a part in the remarkable development that we have witnessed in the past 50 years. Included in the host of useful and interesting tools are lighting fixtures or luminaires, shades, reflectors, lamp holders, ballasts, electric eyes, dimmers, glass, plastics, bulb blowing machines, etc.

When we consider the many phases in the evolution from the first electric lamp to the devices of today we can appreciate how vastly superior is our modern equipment, how enormously enlarged are our opportunities to serve and how greatly increased are our responsibilities to bring the benefits of good lighting to all our fellow men.

One might ask — What have been the outstanding developments in lighting equipment in the past half century? Those that have most greatly influenced the science and art of lighting? The answer will depend greatly upon the individual to whom the question is put — his point of view, his experiences, his personal knowledge of the development of the art.

A compilation, recently appearing in one of our popular magazines, of the 100 most important people in the world revealed that our lives are being influenced by persons that we would not even suspect. For example: A Japanese painter and a Theologian of India. In the realm of lighting equipment the "most important" devices in shaping our progress in illumination applications may be things that we might not, at first, consider as having major influence. For example: the lowly sign receptacle — the product of the mind of a Chicago inventor — a simple device that had a far-reaching effect — one which practically revolutionized the making of electric signs for advertising.

In the illustrated text that follows, an attempt is made to record those devices that have been considered as most significant by a large group of I.E.S. members, who assisted in the gathering of information for this discussion on "Lighting Equipment." Obviously there was a diversity of opinion; in one case there were 68 different answers to one question, yet there was sufficient agreement to justify the selection that is used in the various categories to follow.

In this brief review of "Lighting Equipment" of the past half century, the subject is divided, for convenience, into five sections, each dealing with a separate phase. Light sources are not included here.

The first section treats of and illustrates some of the developments in devices for the *Control of Artificial Light*, in quantity, quality, distribution and color.

The second has for its theme some of the developments for the *Control of Glare* from artificial light.

Next section combines developments that have been effective in influencing the "*Art*" *of Lighting*, as well as that of *Architectural Design*.

The fourth section is devoted to a short discussion of *developments* in lighting equipment *due to Changes in Light Sources*, and the final discussion takes up the very important subject of devices and methods for the *Control of Daylight*.

The illustrations are intended to be merely typical of each category and include those voted to be most significant. No attempt is made to discuss the numerous or proper applications of the means or equipments described or illustrated. This is a subject for another department in the Anniversary Issue of ILLUMINATING ENGINEERING. Nor has any attempt been made to arrange the exhibits in chronological order.

Control of Artificial Light

When the Illuminating Engineering Society was founded in 1906, we possessed some very serviceable devices for the control of light from the sources then available. These sources consisted largely of the carbon filament lamp, the gas burner, the carbon arc lamp, the kerosene lamp, the acetylene source and the mercury arc.

Glare had not yet become the annoying factor that it is today. Therefore, the emphasis of the lighting engineer was largely on the design and development of accessories that would control the rays from the sources for greater utilization. The control of light throughout the whole of the 50-year period has continued to be a major occupation for the lighting specialist.

In reviewing the most significant developments for *Light Control*, we may consider that the subject divides naturally into two broad classifications — (1) Reflecting and refracting media, and (2) Transmitting, diffusing and absorbing media, with an additional class of special accessories for light control.

The use of the metal conical shade (Fig. 1) was probably the first attempt at reflecting light downward from the pendent lamp bulb. The shades had painted white interiors; some were sprayed with white aluminum paint to improve reflecting qualities. Then followed a succession of other designs in mirrored glass, prismatic glass, polished or plated metal, porcelain enameled metal and opalescent glass. The first two gave the designer an opportunity to control light rays with considerable accuracy; to concentrate them into a powerful, narrow beam, or spread them over a comparatively wide area, or again to produce a non-symmetrical shape to the "pattern" of light distribution (see Fig. 7). Accuracy in the design of the contour of reflectors, is responsible for the nicety in control of light. Thus the reflector or shade has become one of the greatest agencies for the proper utilization of artificial light.

As the art of light control progressed studies were made of reflection from surfaces and materials other than those mentioned above. A notable development has been the "Alzak" process for producing a permanent reflecting surface on aluminum, either of polished or slightly diffused character. These compare favorably with some of the glass media previously employed.

While polished or specular surfaces permitted the greatest degree of light control, it was found that some surfaces produced a so-called "spread" reflection, as for example, etched or deep polished metals. Others produced a "diffuse" reflection, as from flat paints and other mat finishes and materials.

The development of synthetic paints and enamels has stimulated a wide spread use of these materials for interior finishes, to the extent that one must now consider wall and ceiling decorations in any properly engineered lighting plan. The co-efficient of reflection of lighting accessories and of painted surfaces are closely interwoven factors in light control for any interior.

Recent years have witnessed a remarkable degree of progress in the use of lenses, prisms and refractors, for the control of light. The property of refraction or "bending" of light rays has been utilized in the design of many useful devices. Chief among the control mediums has been the prismatic reflector and lens units produced in large variety of shapes and sizes, useful for interior lighting, for floodlights, auto headlights, picture projection, telescopes, sidewalk lights, windows, skylights, street lighting units, etc., in flat, cylindrical, or variously moulded designs.

In the category of transmitting, diffusing and absorbing media, there have been made available many kinds of sheet and plate glasses, with surfaces designed to control light. First, sanded or etched glasses were produced—they were inefficient in their light-transmitting value and were succeeded by configurated or patterned or ribbed glasses. We now have a large selection from which to choose with known transmitting and diffusing characteristics. Included are the so-called "Flash" glasses having a lamination of white or colored glass on clear glass. Also included are solid opal or white glass, solid colored glasses of various densities. Refinements in glass making have produced new types of moulded or "sculptured" glass for control of light when decorative values are important. Even a glass having heat-absorbing qualities is available for specialized applications.

Plastics are substances which may be readily formed and retain their form over a period of time. This definition includes glass, clay, cement, organic plastics. For our purpose in lighting we think primarily of the synthetic organic plastics which are formed by the application of heat and pressure. The materials used cover a wide field in general, depending upon the base used in their manufacture. The products may be had in sheets or cast in any conceivable shape. Plastics have advantages and disadvantages when used in lighting. A critical factor is temperature. However, in many instances they have replaced glass. Among the many plastics now available are clear types, some opaque and others translucent and diffusing.

Figure 1. Figure 2. Figure 3. Figure 4. Figure 5. Figure 6.

1. Metal reflector. 2. Opalescent glass shade. 3. Prismatic glass reflector. 4. Mirrored glass reflector. 5. Porcelain enameled metal reflector. 6. Reflector design for unsymmetrical light distribution.

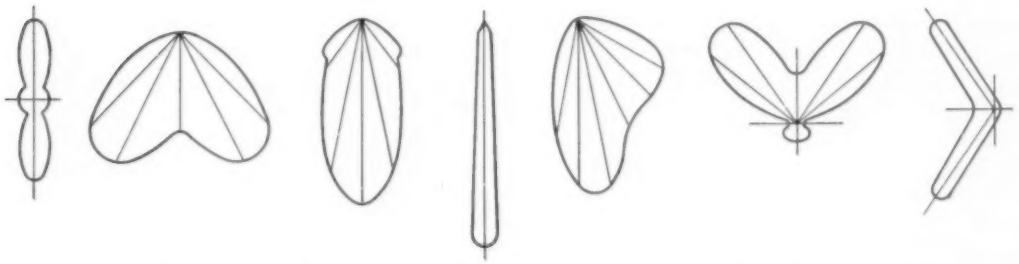


Figure 7. How light may be controlled — various patterns of light distribution.

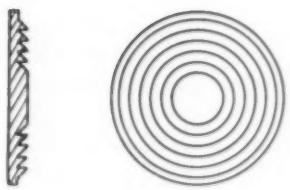


Figure 8.

Figure 9.

8. Lenses change the direction of light rays. 9. Glass in sheets or plates — ribbed or configurated.

Figure 10. Figure 11.

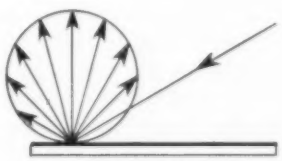


Figure 12.

10. Typical device for "dimming" light. 11. Typical device for "flashing" on and off lighting circuits. 12. Light reflection from synthetic enameled or paint surfaces.

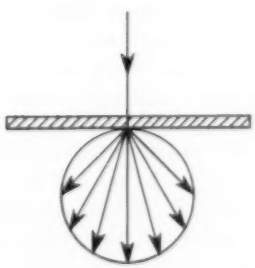


Figure 13.

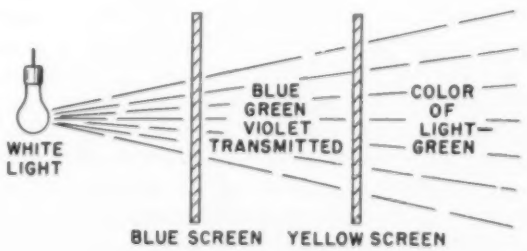


Figure 14.

13. Distribution of light transmitted through diffusing plastic sheet. 14. Control of color by screens and filters.

Much of the plastic material has been used for lamp shades, built-in lighting, in cars and buses, semi-indirect lighting fixtures and, of late, extensively for luminous ceiling areas and translucent louvers.

An important aspect of light control concerns color. With color in lighting we have one of the most subtle tools for developing the refinements in our art of illumination. With each lighting season there is a broader use made of color and a consequent enlargement of the sphere of color in lighting exteriors and interiors. The color media with which we now have to work have evolved as the art progressed. We began with colored fabrics, gelatin screens, lamps dipped or sprayed in color. These were fairly satisfactory but when heat and fading factors were encountered they did not wholly fulfill the requirements. Continued service caused them to lose character and efficiency. Eventually glass plates with color incorporated and of heat-resisting quality were produced by the glass makers. This solved the lack of stability of color and replacement costs. These plates have become widely used for both commercial and decorative purposes, with the result that color control became popular in such applications as show window displays, theatre interiors, exterior flood lighting of buildings, exhibitions, clubs and even in church interiors.

Specialized uses of controlled color have been incorporated in devices and equipment for color-matching of fabrics and of paints for various uses in stores and manufacturing plants employing specially designed, scientifically produced filters. Static color control has been frequently supplanted by a system of mobile color produced by special devices, using "color organs," flashers and dimmers with color effects ever changing and blending from one tone or combination to another.

Many special accessories for light control have been devised, too numerous to be here described. Among the notable ones are photronic cells, time switches, dimmers, flashers, relays, etc.

Control of Glare

The first electric light sources, kerosene and gas burners, were of such low brilliancy that they were not annoying to the human eye. Many of them were used unshaded. Protection of the delicate mechanism of the eye from these illuminants was not generally considered necessary. However, some authorities even at that time stated that exposed light sources decreased the efficiency of the visual function by a considerable percentage. Eight years before the Illuminating Engineering Society was founded, London oculists petitioned Parliament to pass a law prohibiting the use of unshaded electric lights, claiming that people would become blind if eyes were exposed to such sources in streets, shops and offices.

Although the modern lamp has given us the means of securing ample illumination cheaply, we have found that its effectiveness is partially destroyed if we expose our eyes to its intense, unshaded brilliancy. Such exposure fatigues the eye, causing strain of the ocular muscles, nervousness and headaches, all of which incapacitate the individual and in time may cause permanent defects of vision.

The day of the exposed light source definitely passed with the introduction of the gas-filled incandescent lamp. The eye of man rebelled and it was necessary to conceal the new source from direct view. Our concept of glare from light sources had to be re-evaluated in view of the fact that the trend in the application of artificial lighting was ever toward the use of larger, more efficient and vastly more brilliant units. Glare had become the most common and serious fault with lighting installations, a hindrance to vision and a definite waste of energy.

In 1919 the Illuminating Engineering Society published a booklet entitled "Light — Its Use and Misuse," which stated "do not think because a lamp looks glary and brilliant that it is giving good light."

Eye-protection methods developed slowly but glare control did come and with it many benefits — ease of seeing; a sense of restfulness in lighted interiors; revelations of new beauty — these and many more have become realities because of the various means devised to minimize harmful glare.

The publication of results of extended scientific research projects on the effects of glare has stimulated activity to correct this insidious evil. Eye specialists and illuminating engineers have cooperated in effecting better visual acuity from our lighting systems; greater seeing comfort and consequent improvement in visual health. The contributions of the architects and decorators must also be acknowledged in assessing the beneficial results of joint professional responsibility in a campaign against glare.

An adequate discussion of glare leads us into a comprehensive and involved study. No attempt can be made here to analyze the various factors causing and affecting glare. We can merely briefly review some of the methods and equipments that have been devised during the half century to mini-

Figure 15.

Figure 16.

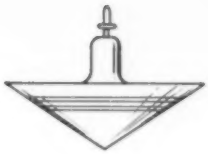


Figure 17A.

Figure 17B.

15. Ball of opal or white glass. 16. Enclosing glass bowl fixture. 17A. Semi-indirect glass fixture. 17B. Semi-indirect metal and glass fixture.

Figure 18.

Figure 19.

Figure 20.

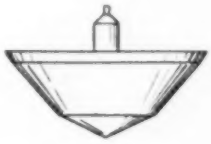


Figure 21.

18. Indirect fixture with mirrored glass reflector. 19. Diffusing glass bowl with top pan reflector. 20. Indirect luminous bowl type fixture. 21. Plastic semi-indirect fixture.

Figure 22.

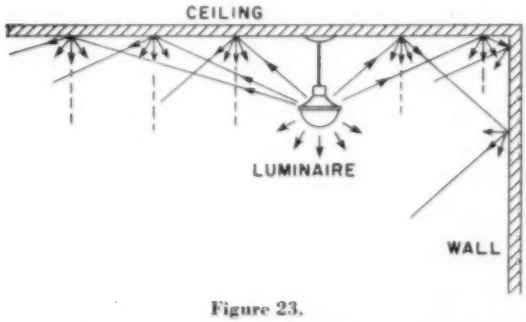


Figure 23.

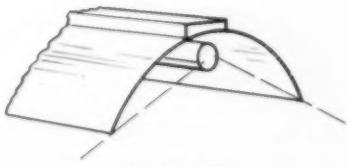


Figure 24.

22. Gas arc lamp. 23. Diffusion principle of indirect and semi-direct 24. Deep reflectors and shades to conceal light sources.

mize the conditions that interfere with comfortable vision. We think of glare in various terms such as disability glare, blinding glare, discomfort glare, veiling glare, annoying glare, etc. However, for the purpose of this brief discussion, we shall classify equipment and methods for the control of glare into two categories:

(a) Those having to do with *direct* glare, caused by the excessive brightness of the source.

(b) Those relating to *reflected* glare, as caused by the reflected image of the light source.

To combat *direct* glare, one may do one or both of two things — first, apparently *enlarge* the visual size of the source of light, thus reducing its brilliancy per unit area, or effectively *shield* the source from direct view.

Among the first attempts to enlarge the source was the employment of a globe of sanded or white glass to completely surround the lamp, acting to soften and diffuse the light. This method was extensively used for all types of sources, electric, gas, Nernst and arc lamps, etc. (See Fig. 15 and Fig. 22.) Following the simple globe, glass balls and "stalactites" in manifold forms were introduced, many of elaborate cut glass and some of striped glass in colors. These had so-called decorative qualities but were hopelessly inadequate as glare reducers and were also intolerable from an aesthetic standpoint.

Improvements came along in the form of etched and opalescent glasses. Care was exercised in design to avoid offensive bright spots, which was one of the chief objections to the cut glass globes. Eventually the Illuminating Engineering Society

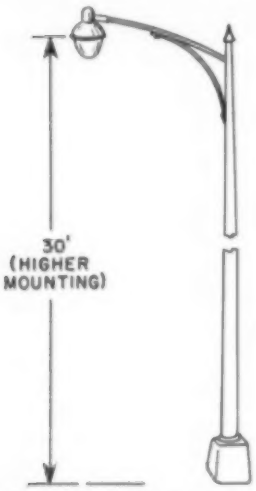


Figure 25. Higher mounting for street lights.

Figure 26. Sun glasses, tinted or polaroid.

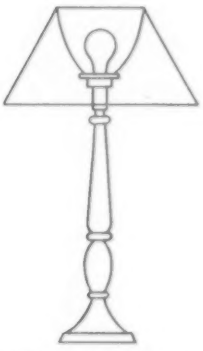


Figure 28. I.E.S. study lamp.

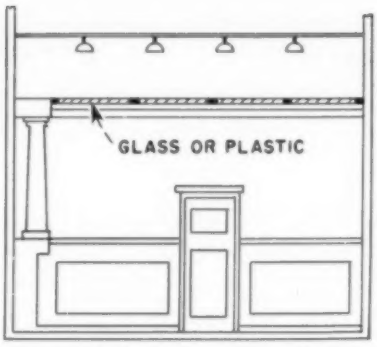


Figure 27. Luminous ceiling of glass or plastic.

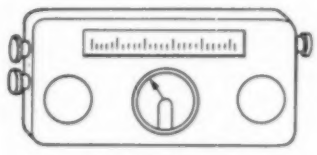


Figure 29. Brightness meter.

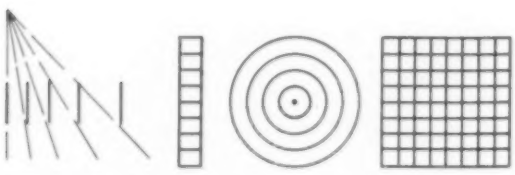


Figure 30. Louvers of egg-crate or concentric type.

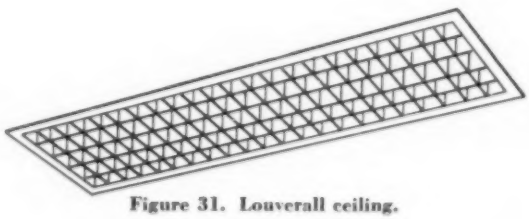


Figure 31. Louverall ceiling.

established standards for the permissible brightness of globes per unit of area and the globe became an acceptable device in the conquest of glare. The glass ball evolved into the "enclosing bowl," as in Fig. 16 — a unit that presented a comparatively larger luminous surface of lower brightness.

Soon after the turn of the century, the commercially feasible indirect lighting system was introduced — a radical departure from methods then in vogue. The light from the source was directed upward by a mirrored reflector, thus causing the ceiling to become the secondary source of light — an extensive source of low brightness. This resulted in a so-called "soft" illumination in the interior. There followed rapidly numerous types of indirect and semi-indirect fixtures utilizing glass, metal and plastic bowls. The glass bowl fixture especially came into great favor, chiefly due to the fact that it was luminous. However, for some time there was considerable difficulty in securing glass ware of desirable density. Eye comfort and artistic considerations demanded a bowl of low brightness — this desirable condition was finally attained.

Other means of apparently enlarging the source of light included glass ceilings or skylights of diffusing glass illuminated from above. Here again the source became a large luminous area of low brightness tolerable to the eye. A more recent innovation of a similar nature is the luminous ceiling wherein the glass diffusing medium is replaced by organic plastics.

The second major method of dealing with direct glare is that of shielding the source. The most simple means included the use of a "shade," which also normally performed the function of a reflector to modify or control the distribution of light. The deep reflector has been especially effective in shielding. Other devices and methods that have made important contributions in this category are louvers, low-brilliancy troffers, sun glasses, shielded "down lights," louvered luminaires, photolite glass, the I.E.S. study lamp, high mounting for indoor and outdoor fixtures, especially those for street lighting. Many of the equipments for shielding have been designed to have decorative qualities in addition to their screening value.

Direct glare may often be virtually eliminated

by the selection of proper equipment, but this is not always true of *reflected glare,* which may come from any glossy surface, such as a polished desk top, a piece of specular metal, calendared paper or a wet pavement at night. The more diffuse the lighting source and the lower its brightness the less annoying will be the reflected image of that source.

Usually the remedy for reflected glare lies in the proper treatment of the surface that reflects the image of the source into the eye. To this end the finishes of walls and floors have been modified, finishes for furniture and machinery have been dulled, the surfaces of pavements on our streets and highways have become darker in an effort to combat glare, linoleum desk tops have been introduced and polaroid glasses and sheets have been found to be effective.

Scientists and engineers are constantly working on methods to evaluate properly designed brightness relationships. "Glare ratings" are offered as a major contribution to this universal problem and the brightness meter has been devised as an important tool in the conquest of glare.

The Lighting Art and Architectural Design

The accumulated specialized knowledge relating to lighting practice may be called the science of illumination, while the proper use or application of the scientific tools and truths is a fine art — the art of Illuminating Engineering. There are certain rules to be followed, certain utilitarian ends to be reached, but whether the result is brilliantly successful or hopelessly commonplace depends upon the skill and imagination that inspire it.

We are limited in standardizing the application of many lighting principles by the composite nature of our problems. The illuminating engineer must, therefore, share the responsibility with others: the designer, the contractor, the decorator, but most usually with the architect. The mutual efforts of architect and illuminating engineer during the past decades have brought about some very significant changes in both lighting and architectural practices.

Although changes have come about gradually, important steps were taken soon after the introduction of the gas-filled incandescent lamp and when the indirect lighting system became commercially available, extensive applications of "cove" lighting and similar forms were made, utilizing architectural elements for the concealment of the lighting sources. Standardized practice eventually gave way to freedom of expression. Light was then used in new and ingenious ways. A high level of performance was reached in various countries. In Germany, for example, light was incorporated to such a remarkable degree that the descriptive term "Light Architecture" was coined to describe the manner of coordinating lighting effects and structures.

The principal developments affecting the lighting art and influencing architectural design during the past half-century may be grouped into two classes — those involving "Indirect" methods with light sources concealed from view, and those commonly known as "Direct" lighting methods.

For the *Indirect* methods, equipment was especially designed for placement in coves, cornices, niches and ceiling domes, having recesses arranged structurally to receive lamps, reflectors, lamp holders and suitable wiring accessories. (See Figs. 33-34.) Because of varying conditions to be met in interiors, especially those of large public buildings, an extensive variety of control devices were designed by lighting engineers and produced by the equipment manufacturers. In some instances it was desirable to project the light a distance beyond the concealed source; again other conditions required a wide spread of light in adjacent areas. The resulting developments made practical the illumination of extremely diverse types of interiors from high vaulted Gothic structures to rooms with low, flat ceilings.

Invariably the architect provided in his design not only adequate space for efficient lighting equipment but also for contours of the architectural elements that would insure proper "cut-off" angles thus preventing any possible view of the reflectors and lamps, as well as means whereby the lighting device could be easily reached for cleaning and renewals — all essential factors in the successful operation of this lighting method.

Frequently it was not possible or feasible to construct a cove or ceiling dome, but it was nevertheless desirable to illuminate the interior by means of hidden sources. To meet this condition the lighting equipment designer provided equipment of special and peculiar shapes which could be located in wall boxes, in brackets, on posts and pilasters or in the bowls, urns or vases of floor pedestals. (See Fig. 32.) Thus a large and interesting field for the illumination of interiors by concealed sources was opened up. In numerous instances the architectural elements containing the light sources were made agreeably luminous by means of auxiliary lamps, thereby providing an additional decorative touch.

The successful incorporation of large wall and ceiling luminous elements into the design of interiors introduced a variation in lighting method

Figure 32.

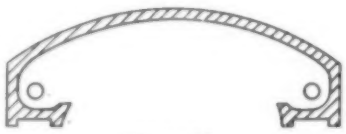


Figure 33.

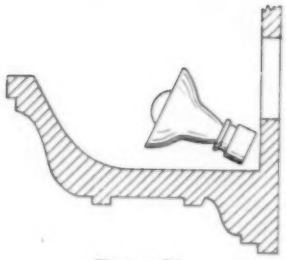


Figure 34.

32. Indirect lighting, pedestal or urn. 33. Dome or panel lighting arrangement. 34. Cove or wall bracket.

Figure 35. Built-in or recessed fixture.

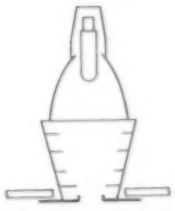


Figure 36. Pin-hole or downlight unit.

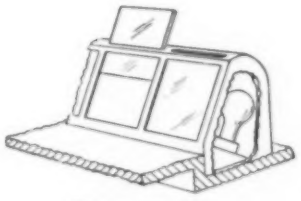


Figure 37. Stage lighting unit.

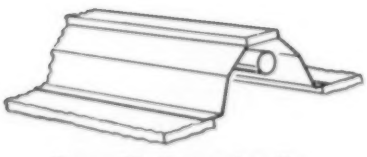


Figure 38. Recessed troffer.

Figure 39. Floodlight.

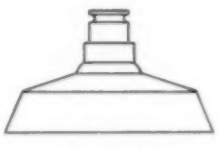


Figure 40. RLM reflector.

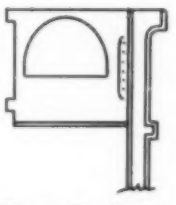


Figure 41. Device for lighting from bank cages.

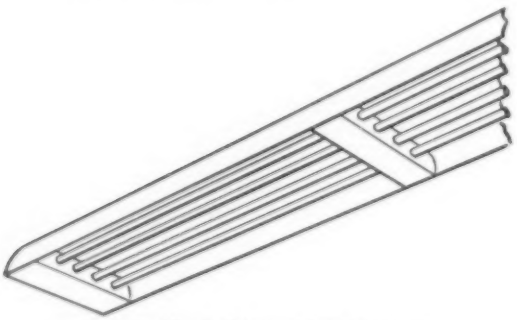


Figure 42. Continuous row fixtures.

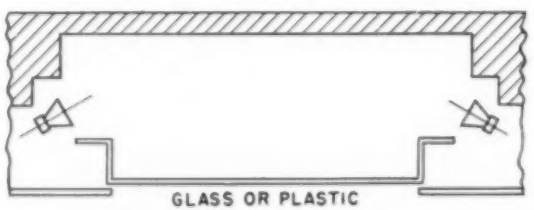


Figure 43. Luminous panels of glass or plastic.

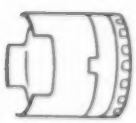


Figure 44. Porcelain sign receptacle.

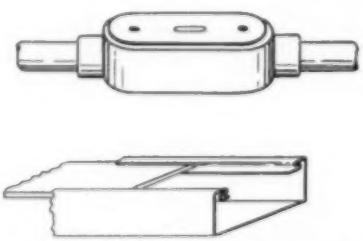


Figure 45. Conduit and wiring channel.

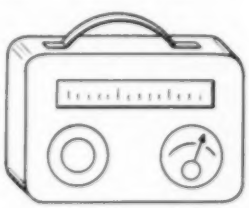


Figure 46. Footcandle meter.

that was both interesting and practical. Examples were to be found in glass panels, strips and cornices through which light was diffused from sources and equipment placed behind. (See Fig. 43.) Artificial windows and entire ceilings of glass, plastic or fabric came into being. Care had to be exercised on the part of the lighting planners to secure uniform brightness and prevent shadows of mechanical equipment and supports. Provision for accessibility for purposes of maintenance was among the responsibilities of both the lighting man and the architect.

Equipment for *Direct* lighting methods developed over the past five decades that have had a definite influence upon the lighting art and architectural design are fully as numerous as those for the "hidden" source methods. Chief among the devices that have been integrated into structures are the troffer, recessed or "built-in" lighting boxes, and the so-called "pin-hole" or "down lights." (See Figs. 35, 36, 38.)

The "troffer," a revolutionary lighting device, brought about a radical change in architectural design for ceilings in offices and other commercial interiors. Its practical application called for a close accord on the part of architect and lighting engineer — many novel ideas of construction must be agreed upon. With the lighting equipment installed above the ceiling level all suspended fixtures were eliminated, giving the room a more spacious appearance. Almost coincident with the introduction of the troffer came an in increasing tendency by builders to use sound-absorbing materials for ceilings. A standardized width of 12 inches for acoustical panels determined the dimension for the flanged troffer lighting equipment. Troffers in single lamp sections or in continuous lengths were devised to meet various requirements. Usually with surfaces of low brightness, with or without louvers the troffer has become a most acceptable lighting tool.

"Recessed" equipment of the type illustrated in Fig. 35 has become a very important element in influencing architectural design. Made available by lighting designers in a great variety of sizes and shapes — deep, shallow, round, square, louvered, plain, glass covered, open — these units provide a wide range in flexibility and adaptability, not only in mechanical make-up and mounting methods, but also in manner of light distribution.

A significant variation of the "built-in" type is the "down light" shown in Fig. 36—a typical "pin-hole" unit designed to light interiors through a small aperture. The mechanical arrangement is such that the reflected rays of light cross at the ceiling opening, spreading over a wide area below. The overlapping of the "circles" of light from numerous units results in an "even" distribution of illumination.

When in 1907 the first large building was illuminated at night by the then new "floodlighting," definite impetus was given to a startling and novel method of revealing the beauty of architectural structures and monuments. Later extensive uses of the method using "white" or colored light emphasized its effectiveness as a medium of advertising for countless applications.

Any review of lighting progress over the half-century would not be complete without a tribute to the very significant contribution made by the reflector design known as the "R.L.M."—a development that profoundly influenced lighting practice. This device represented sound engineering design and around it was formed a notable and far-reaching cooperative movement among manufacturers to improve the art of lighting application, especially in industrial plants.

Mention should be made of sign lighting equipment, continuous row luminaires, wiring accessories such as conduit, and channels, as important factors in our progress.

Lastly, the "footcandle meter" enables the unscientific observer to gain an approximate idea of the value of illumination by a simple inspection. It popularized illumination measurements and directed attention to the importance of correct lighting.

Equipment Development Due to Changes in Light Sources

We surmise that the primitive cave man lighted his abode by means of a mass of burning animal fat cradled in some form of hollowed rock basin or in the skull of a small animal into which a piece of dry moss was inserted as a wick. Thus the first crude lamp made by the hand of man came into being — a light source and its container.

From the earliest times lighting equipment has been "built around" the source of illumination: to house or support the source, to shield the eye from its brilliance or to control its rays, thereby enabling man to use light for his various needs. It is apparent that the light source and its accessory equipment are interdependent. No source can be employed without its complementary device. The extent of the benefit derived from the illuminant has depended upon the skill and perception of the designer of the accessories and his appreciation of the purposes for which the source was developed.

Conforming to Changes in Light Sources

Figure 47.

Figure 48.

Figure 49.

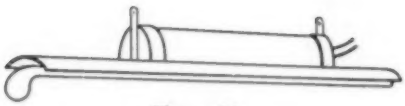


Figure 50.

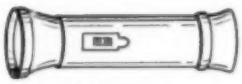


Figure 51.

47. Type of electric arc lamp. 48. Gas mantle wall bracket fixture. 49. Type of gasoline lantern. 50. Mercury vapor lamp. 51. Flashlight.

Figure 52.

Figure 53.

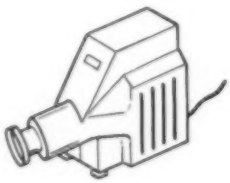


Figure 54.

Figure 55.

52. Photo flash lamp with reflector. 53. Automobile head lamp. 54. Projector for slide transparencies. 55. Silvered-bowl lamp luminaire.

Figure 56.

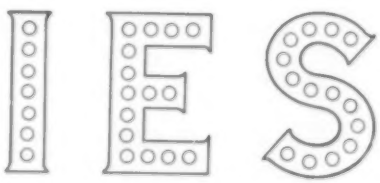


Figure 57.

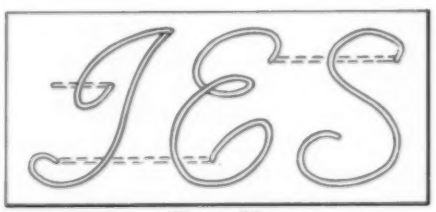


Figure 58.

56. Sun lamp. 57. Electric sign with incandescent lamps. 58. Electric sign with neon tubing.

For a given light source there have been several distinct treatments possible and desirable for its practical use. For example, the candle served for centuries as a household illuminant and the simple candle stick evolved as its supporting fitting. However, in the church the candle received more elaborate treatment at the hands of the designer. The Ecclesiastical fixtures became great "coronas" of light or torchieres, or candelabra or glowing lanterns. The same source of light essentially in both cases of the application of the candle yet a widely different interpretation in equipment design.

Progress in modes of lighting marked the introduction of each new illuminant. The kerosene and gas flames and the electric sources made practically obsolete the candle fixtures that had been produced over the centuries. The new sources required new equipment — each challenged the ingenuity and practical sense of the designer of accessories if he was to keep pace with the advances in methods of producing light.

For decades our conception of a lighting fixture was that of a device suspended from the ceiling with numerous projecting arms, each terminating in a gas jet or a receptacle for an electric lamp bulb. But since the introduction of new sources our conception has changed and the chandeliers of our youth have been superseded, especially in commercial lighting, by totally different creations. In fact, in many instances there is no suggestion whatever of the customary lighting fixture anywhere present in the interior. The relationship, therefore, of

Conforming to Changes in Light Sources (continued)

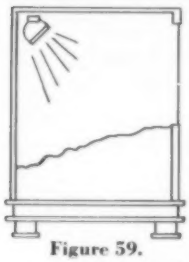


Figure 59.

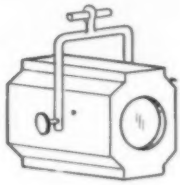


Figure 60.

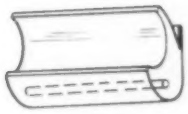


Figure 61.

Figure 62.

59. Display case. 60. Device for projecting "black light." 61. Germicidal ultraviolet fixture. 62. Medical and examination lighting device.

Figure 63A.

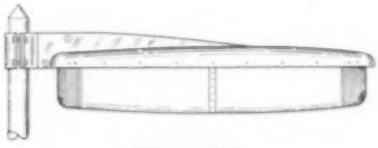


Figure 63B.

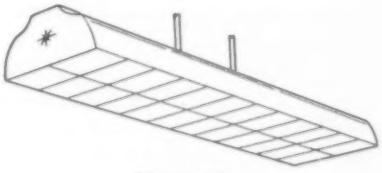


Figure 64.

63A. Mercury vapor street lighting unit. 63B. Fluorescent street lighting unit. 64. Elongated luminaire for fluorescent lighting.

Figure 65.

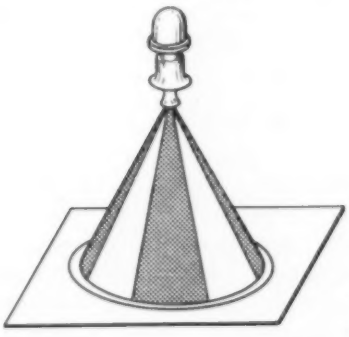


Figure 66.

Figure 67.

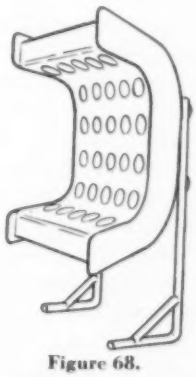


Figure 68.

65. Traffic and railroad signals. 66. Airport lighting unit. 67. Christmas tree. 68. Drying equipment with infra-red lamps.

the light source and the accessory equipment has been gradually altered. However, the influence of the source upon the design has not only been retained but frequently definitely emphasized.

The transition from the very crude and inadequate practices of ancient days to our glittering "white way" lighting of today has required many intermediate steps. These have taken many centuries. The most rapid and the most significant progress has been made, however, in our own lifetime — during the past half century — since the founding of the *Illuminating Engineering Society* in 1906.

What are some of the most important equipment developments resulting from the introduction of new light sources? This is a question not easily answered in this day, characterized by a profusion of sources of various shapes, sizes and ranges in light output. Literally hundreds of lamps are available, each with a specific value in the application of modern lighting. Certain of these sources have been responsible for creating new equipment design and definite trends in lighting practice. Thus the work of the equipment designer has been complicated, yet his task has become more exciting and challenging.

It would be quite impossible, in this brief review, to trace all of the significant developments in lighting equipment resulting from the promotion of new light sources. The sketches in Figures 47 to 68 illustrate a very few of the devices that have come to be a part of our equipment heritage. Some were

contrived for small light sources, others for large, some for filament lamps and others again for gaseous sources. In each case the fitting was designed to support or shelter a light source and direct its rays into useful channels. Many changes in equipment have been due to the alteration of size and shape of the source. For example, the chandeliers and "clusters" of recent decades supported a multiplicity of small filament lamps. An important change in "fixture" design occurred when one large source was made available with a light-giving capacity of many small units. The designers at once saw and grasped the opportunity to incorporate the idea of compactness in newer fittings.

An auxiliary problem — that of greater heat generated by the source, necessitated a study of ventilation of lamp holders and luminaires with consequent changes in design if these large sources were to be safely utilized. The temperatures generated by sources also affected the "finish," paint or otherwise, of fixtures, thus bringing about researches to provide heat resisting treatments.

Another significant innovation was inspired by the introduction of the linear tube-like source. Previous to this the lighting fixture for a single lamp had become almost traditionally round or square in form. Now the creator of luminaires must completely change his approach and devise an elongated rectangular appliance that would retain the mechanical and decorative qualities of the former designs yet be distinctly appropriate in its new dimensions and in keeping with the advances in light sources.

Still another problem encountered by the equipment man involved the design of reflectors for the filament lamp. A reflector shape that would focus rays at the "light center" would greatly increase the temperature of the filament and result in a shortened life for the lamp. Hence the reflector design must be revised to alleviate this possibility and a contour developed to insure that the rays would "miss" the filament.

Again large sources are more brilliant than their smaller counterparts. Numerous developments in method and equipments came about because of the need for "hiding" or shielding the source. The whole range of Indirect and Semi-Indirect fixtures and louvering devices were the logical result of this condition. In addition to the above somewhat obvious changes in the lighting appliances for commercial and industrial institutions, there were innumerable designs created in many specialized fields. In domestic lighting, for example, a revised type of portable lamp was produced to accommodate the two-filament lamp, thus increasing the flexibility and usefulness of this popular household item.

When the Illuminating Engineering Society was founded the typical automobile headlight had for its source an acetylene burner, evidently satisfactory for its day when one recalls the speed then attained by motor cars. A few years later as car speeds increased researchers brought out a small lamp of the filament vacuum type to be operated by a battery. Here again equipment must be redesigned. The natural tendency was at first to retain the fundamental shape and size of the head lamp housing then in vogue, but changing details of light source supports and connections to the power supply. However, two or three years' experience told us that good road lighting could be secured by projecting the light beam far forward by means of a carefully designed deep parabolic reflector, and thus progress was gradually made toward our present type of automobile headlamp.

The equipments that have been created for use with the so-called "miniature" light sources are numerous, useful and frequently fascinating. The now popular "flashlight" might well be called a masterpiece of compactness and serviceability; a tiny light source with its own power supply, an efficient beam reflector and a reliable switching mechanism. A "gadget" that we so frequently take for granted but one that is the result of the inventive genius of many minds.

In the realm of photography a small lamp caused a complete revision of "flash" equipment with a later incorporation of the now universally used synchronizer that coordinates the "flash" of the lamp with the opening of the camera shutter.

Add to this the apparatus that designers have produced for the projection of pictures by amateurs and professionals, commercial and portrait studio reflectors, photo spot lenses, modeling lights, motion picture studio lighting equipment, etc., and we have an intimation of the tremendous number of devices that have assisted in the expanding and popularizing of the photographic art.

The sketches in Figures 63, 65 and 66 are a mere suggestion of the equipments that have been created to serve the transportation field. They all began with the light source as a basis and developed gradually to meet the needs of this enormous and expanding activity. In addition to street lighting units and those for highway traffic regulation and airports, there are numerous others that can but be mentioned; namely, lighting equipment for busses, railway cars, locomotive headlamps, air planes, ships, landing fields, railway signals, etc. —

a whole category in just this one area of lighting practice.

To meet new conditions encountered in our progress toward a more perfect social and economic life, the sciences and arts are constantly evolving new products. In the realm of lighting, the new era may be considered to be one of lighting effects produced by carefully designed and thoughtfully applied equipment rather than one merely of light sources. Given a new light source, the competent designer will exercise freedom and judgment in deciding on details of his creation, consider the demands and the limitations of the application, whether it be one requiring "efficient" lighting, purely decorative or one that involves totally new concepts for which little or no precedent has been established. In any case the exercise of his creative genius usually results in a new and useful lighting tool "built around" the light source.

Even a cursory inspection of a representative group of lighting equipment manufacturers' new and old catalogs and brochures will reveal an astounding wealth of devices from which to select, by those called upon to discriminate in the use of lighting equipment. This inspection will also accentuate the startling, unprecedented rate of progress our lighting art has experienced in the past half century.

Developments for Control of Daylight

The first early morning rays of the sun brought to primitive man, just as they do to us today, a release from the bondage of night darkness. Creatures stirred and activity began when the light appeared. In all ages men have recognized daylight as one of our greatest benefactions. Ancients worshipped the sun. Even the earth's vegetation looks to this source of light and grows toward it.

Sunlight is almost indispensable to life. Shut out the sun's warm and potent rays from living things, plant, beast or man, and a part of life itself is taken away. Life can exist for a time in darkness but it will lack in vitality. Sunlight not only makes for fullness in our physical life but also contributes to our spiritual needs.

Even primitive man was reluctant to give up all daylight when he entered his crude abode. His solution was to fashion an opening in the wall of his cave to admit some bit of light from the sky. His uses of daylight were indeed simple in comparison to those of our complex civilization. Primitive eyes were used for distant seeing largely, while ours today are called upon to perform a multitude of seeing tasks.

In daylight we have an incredible quantity of light available for illumination, generously provided by nature. Our responsibility is in its careful and intelligent use. The adequate utilization of this gift of nature involves many important considerations. However, our brief review here will include but two basic factors: first, the methods generally employed for admitting daylight into interiors, and second, the means that have been devised for its effective control.

The most obvious method of admitting daylight into interiors is by means of side wall windows and ceiling skylights. Although the supply of daylight is great, the amount that enters any given interior depends largely upon the area of sky visible from the windows. This factor, called the sky angle, is influenced by the conditions outside and adjacent to the windows. If trees or buildings are nearby the light supply is definitely modified. The presence of clouds in the sky and the location and altitude of the sun affect the amount and quality of light entering any interior. In offices, school rooms, homes or shops but a small percentage of the daylight that reaches the window is effective in lighting the interior. Hence it is important that we gather as much as possible of nature's light if we would avail ourselves of its benefits.

For all practical purposes the windows, whether or not they have an unobstructed view of the sky, may be considered the sources of light for the interior. Exterior objects such as building walls or light courts may obstruct light yet they may contribute by having their surfaces finished in light diffusing tones, thus acting as reflectors of the skylight or of the sun's direct rays.

Many interiors have what is termed "uni-lateral" lighting with windows in but one wall. In this case desks and machines farthest from the windows will be relatively dark. For school rooms and factories architects have created designs that provide for additional daylighting, bringing it into the area of the room away from the window wall. Such methods include clerestory windows and monitors as shown in Fig. 79. This arrangement gives us the so-called "bi-lateral" lighting which affords greatly improved uniformity in the lighting values in a room. Developments in window design, including improvements in framing, enlarged glass area, and window placement, are all effective in bringing more daylight indoors. In the case of the large "sill to ceiling" type, the window virtually becomes a clear transparent wall, as in Fig. 69.

Frequently architects and engineers resort to the device of orientation of the building, relating the structure to the normal position of the sun to secure a maximum of sunlight. The local condi-

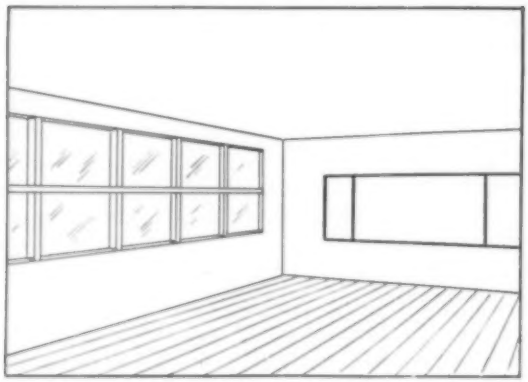


Figure 69. Improved fenestration.

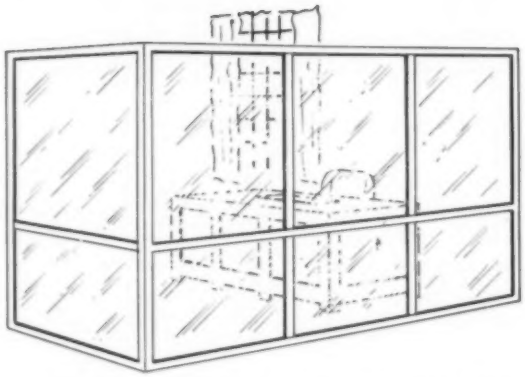


Figure 70. Glass partitions for transmitting daylight.

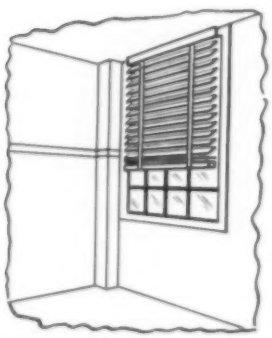


Figure 71. Improved Venetian blinds.

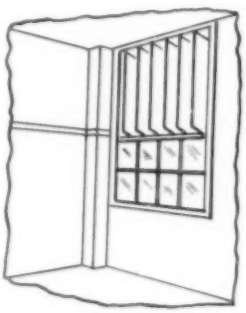


Figure 72. Vertical louvers for windows.

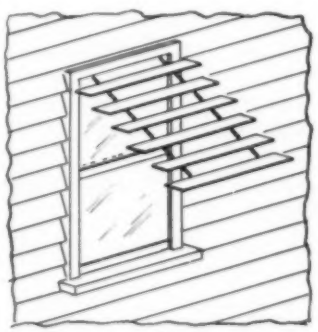


Figure 73. Outriggers or baffles.

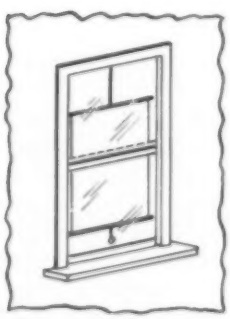


Figure 74. Center-hung blinds and shades.

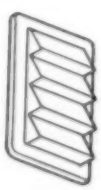


Figure 75. Prism glass for transoms.

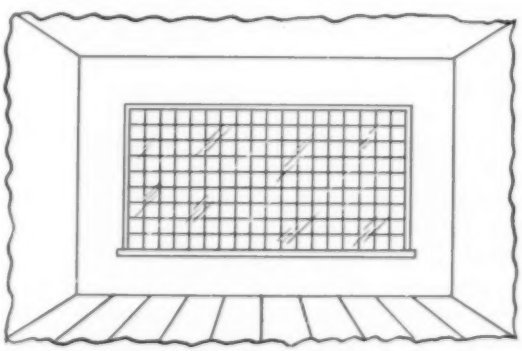


Figure 76. Glass blocks for admitting daylight.

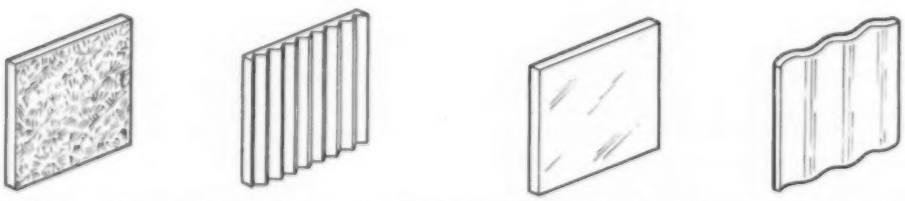


Figure 77. Types of improved plate glasses — configurated-diffusing, ribbed, tinted or heat-absorbing, corrugated.

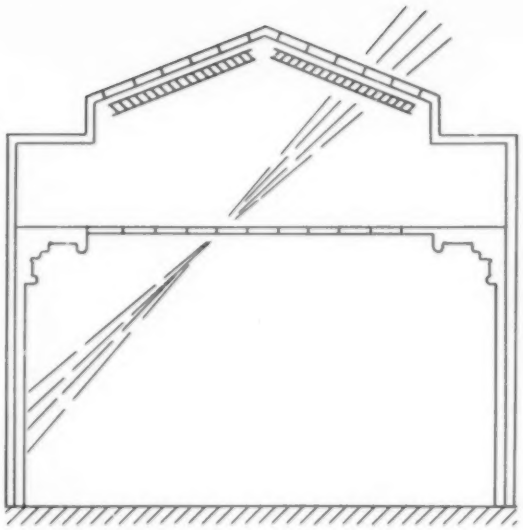


Figure 78. Skylight with adjustable louvers.

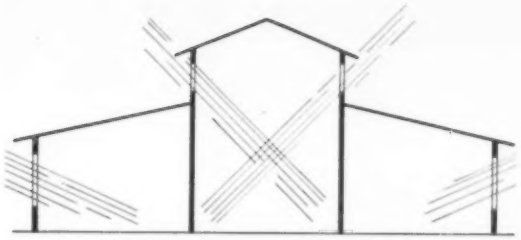


Figure 79. Monitor roof and clerestory windows.

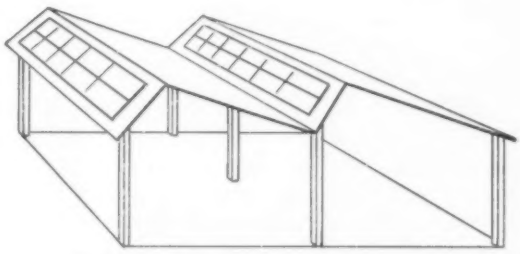


Figure 80. Saw-tooth roof construction.

Figure 81. Electric Eye—photronic cell.

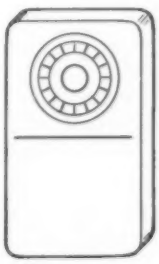


Figure 82. Time switch for electrical circuits.

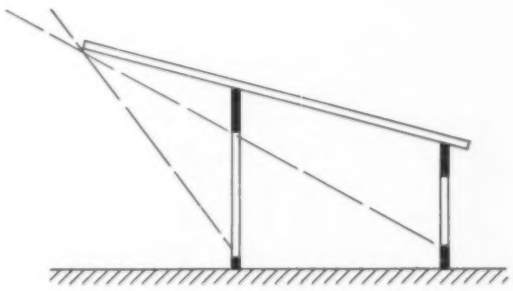


Figure 83. Solar architectural construction.

tions and requirements govern the arrangement of the plan in this instance.

Skylights or roof windows are frequently incorporated in building design to increase the daylight ilumination. These may take the form of a flat glass ceiling with an outer skylight or a sloping "saw-tooth" construction as shown in Fig. 80. A common practice with the latter is to face the "teeth" to the north to secure the benefits of the daylight with a minimum discomfort from direct sunlight. In industrial plants there are many special operations for which skylights provide the most effective means of securing even daytime illumination.

Partial or solid walls of glass using the "glass block" as a material of construction are rapidly becoming a permanent method of admitting daylight into interiors.

After we have solved the problem of getting daylight into interiors our task then is to adequately and profitably control it. We have numerous means and equipment for so doing. Broadly these consist of blinds or shades, awnings and various types of glass.

Since most interiors will have direct sunlight or skylight part of the day, it is essential to provide shades for screening. The shades commonly used perform the functions of diffusing direct light, reducing glare from the visible sky and assisting in reducing specular reflections from polished surfaces.

The code for school lighting states that window shades should be of diffusing light colored material. Also, since the light that enters the top of the

window is most effective in lighting the farther side of the room and that admitted at the bottom contributes largely to the near side, thought should be given to the use of two roller shades operating from the center of the window — one to be rolled up and the other down. See Fig. 74. This will provide the maximu melasticity for the shading and diffusing of the light. The use of the double-hung shades is applicable to other types of interiors.

For the upper sash of windows a "diffuser" of glass on fabric is frequently and effectively used to reduce unnecessary brightness and as a means of better utilization of daylight. These are usually installed at 30 degrees to the vertical.

The improvements that have been made in construction of Venetian blinds of wood, metal or fabric, horizontal and vertical, contribute to the adjustable and flexible means of admitting and controlling daylight, adaptable to all kinds and sizes of windows. These louvered blinds also give us a method of projecting light into the interiors if their surfaces have a high reflecting value. See Figs. 71 and 72.

Similar arrangements on the exterior of the window may be resorted to in the form of "overhangs" in unlimited variety; louvered awnings, jalousies or baffles, fixed or movable, for light control, reducing excessive sky glare, and screening direct rays of the sun, yet admitting the daylight. See Fig. 73. For art museums and other large public buildings with skylights extensive, stationary or movable louvers may be utilized for controlling the distribution of light within certain limits, as illustrated in Fig. 78.

An interesting innovation in the construction of homes especially, is worthy of note; that is, recourse to the architectural style known as the "Solar House" with its lengthy outreaching roof designed to shield the direct rays of the sun from entering the house — particularly when the window walls with large "picture windows" are an element in the design.

The gradual recognition of the value of glass in the construction of buildings for the admission of daylight, a greater knowledge of the physics of glass, the improvements in transmission and diffusion, the lowering of the relative cost of glass as compared to other structural materials, the potentialities of the use of glass for decorative and other special effects — all these together have played a conspicuous part in the remarkable increase in the use of glass in the past decades.

Glasses commonly used for glazing windows and skylights may be had in a variety of types: clear, sanded, etched, configurated, colored, coated, ribbed, prismatic, patterned, etc., each having definite characteristics as to transmission values and diffusion patterns, and each having definite and particular appropriateness in its practical application.

The sun's radiation entering a space enclosed with glass is partially transformed into heat energy. A type of glass has been developed to absorb a proportion of this energy. Manufacturers claim that 65 per cent to 80 per cent of the heat rays are blocked by this glass yet 75 per cent of the light is transmitted. The specialized instances for the employment of this material include hospitals and show windows.

An interesting method of admitting and controlling daylight into basement areas under sidewalks, especially in large shopping centers, is by means of a "bull's eye" inserted in the sidewalk. Numbers of these round or square lenses spaced a few inches apart are effective when the direct rays of the sun pass through them. Directing prisms moulded into the "bull's eye" deflect the rays and thus increase the daylight illumination at points distant from the point of entry of the light.

Many and varied are the uses for specially designed glasses utilizing daylight for decorative and unusual effects. Tinted and colored glasses have long been a feature in the beautiful art windows of cathedrals and churches. Types known as sculptured and moulded glass are frequently the work of our foremost designers. Deep cut diamond patterns and "glister" glass add sparkle and gaiety in many interiors by transmitted light.

A striking example of the successful use of daylight and tinted glass for the control of "mood" is to be found in the tomb of Napoleon in Paris. The altar is in the apse and has at its rear a window of golden hue. The light falling into this part of the interior is always bright regardless of the character of the daylight passing through the window, thus symbolizing a living presence. The tomb proper is in the rotunda and here the sun's rays are greatly subdued by passing through blue tinted glass — one feels that here he is in the shadows. The total effect is felt as soon as one enters. The beholder is possessed by a feeling of awe and is impressed with the sanctity of this historic monument.

Whether for the physical demands of seeing, for our needs of the spirit, for the creation of moods or for whatever purpose in our work, our play or our worship any study of light and lighting might logically begin and end with a contemplation of Nature's light, daylight, which, as the poet said, "without whose vesting beauty all were wrapt in gloom."

EXPOSITIONS— MILESTONES IN LIGHTING

As a herald of "things to come," the international exposition scores high in the field of artificial illumination. In fact, expositions have not only shared in the continuing progress of lighting, but lighting, itself, has contributed to the success of every world's fair since the introduction of Edison's incandescent lamp in 1879. Before this, exposition activities halted at dark.

When Queen Victoria raised the popular trade fair to the dignity of an international event in 1851, even the magnificent splendor of the gigantic Crystal Palace — 18 acres under glass — had to surrender to darkness. Nighttime brought fair activities to a close for the day, as there was no satisfactory method of providing lighting for the circulation of visitors and the viewing of exhibits.

It wasn't until the World's Columbian Exposition, in Chicago in 1893, that there was any attempt to provide illumination on any scale, although it was reported that the first filament lamps were used in an Exposition in Paris in 1889. Nearly 65,000 carbon filament lamps of the "stopper" type were used for display, while some 9,000 arc lights flooded the grounds and lighted the exteriors of the buildings. This exposition marked the beginning of a new era in architectural design, and it furthered the practical use of electrical lighting.

Expositions can influence the tastes, habits, and activities of the people who view them. They mirror their time and permit a glimpse into the future. In doing this, they provide a means for business and industry to test the public response to new developments and ideas. For consumers, the fairs are immediate entertainment and education; for business, they are promotional and a guide to long range planning.

The atmosphere of a fair is, in itself, ideal conditioning for the development of accelerated advances in almost all fields. Since the works are temporary, designers are willing to risk brief public disfavor in the interest of originality and progress. Industry can show working models of projected products or techniques and then bring to practical reality those units receiving favorable public reaction.

So it is that the progress of artificial lighting as chronicled through the years of international expositions is essentially an advance history of actual lighting practice. While it must now be said that the many years elapsing since the last fair of "world" caliber have permitted actual practice to move beyond anything shown at expositions, many of the lighting techniques that make up today's standard practice were introduced at past fairs.

Chicago, Buffalo, St. Louis, San Francisco

If the Chicago fair of 1893 introduced artificial lighting as a practical tool, subsequent expositions developed the techniques of its application. By the beginning of the 19th century, America had wholeheartedly adopted the incandescent lamp. The Pan-American Exposition, in Buffalo, in 1901, became a nighttime spectacle, giving the world large scale outline lighting. Outline lighting reached a peak

with the Palace of Electricity at the St. Louis Universal Exposition in 1904.

In the Panama Pacific Exposition in San Francisco in 1915, lighting truly came of age. D'Arcy Ryan, organizer of the first illumination laboratory and the leading figure in the lighting of expositions, met with the architectural commission and convinced its members that lighting was an essential element of the architecture, and, more important, that a coordinate department of illumination should participate with the architects in the design of the buildings and grounds.

Since lighting could now offer definite techniques, this cooperation brought effective results at the San Francisco fair. Lighting revealed the full beauty of the architecture, it highlighted the facades and towers, revealed the ornamentation, and emphasized the colonnades, balustrades, and other elements. Pools of water were used as reflecting basins to multiply the effectiveness of the scene. Large luminous sources lighted the plazas and circulation areas, and the lighted banner became an important feature of the design.

Philadelphia, Barcelona, Paris

In 1926, the Sesquicentennial at Philadelphia used these same techniques and added effectiveness of colored lamps. An outstanding example, still remembered, was the Luminous Liberty Bell. It was a tremendous replica, 51 feet in diameter, with lamps on 6 x 6-inch centers covering the surface. Amber, ivory and old rose lamps emphasized form. At Barcelona, in 1929, the use of color in water, on buildings, and in decorative street luminaires, combined in a constantly changing pattern, made illumination the primary attraction at the International National Exposition. Original designs in the form of large luminous floral and plant figures lined esplanade and pool.

For the Exposition Colonial Internationale, in Bois de Vincennes, outside Paris, in 1931, French designers used conventional techniques but turned their attention to delicate patterns in light and shade. An example of this was the 200-foot Grand Signal Tower with its feathery spray of water. Indirect street lighting, introduced at this exposition, had considerable influence on later fairs.

Chicago — 1933, 1934

The complete control of the visual environment possible through the use of artificial lighting influenced the designers of Chicago's Century of Progress, in 1933, to construct most of the exposition buildings without windows. In utilizing the mobility and decorative qualities of light to present an appealing and convincing story to the public, these interior displays made substanital contributions to the effectiveness of modern store lighting.

In general, the exterior lighting at Chicago was designed as a part of the ensemble to provide a new and effective appearance at night. Patterns of light and shade were evident throughout the fair, and luminous tubing found extensive use along with the principal light sources of that time. For the 1934 version of the exposition, exterior building colors were reduced in variety and lightened in tone. This, plus the extensive use of white, greatly increased the nighttime brightness of the panorama with no increase in the amount of light flooding a given building. While the heavily saturated colors of 1933 may have been more striking, the public reacted with greater favor to the new lighter tones and higher brightnesses.

An innovation at this fair in 1934 was the first large scale combined use of mercury and filament lamps to produce a general level of 15 footcandles of light of an unusual but satisfactory color quality.

San Diego, Texas, Paris

The San Diego Exposition, in 1935, demonstrated artistic application of colored lighting to natural settings. Located in Balboa Park, this exposition took advantage of the beauty of the permanent buildings in their natural surroundings. Foliage was delicately colored and highlighted by lighting equipment concealed in the shrubbery and the natural contours of the grounds. More than anything else, from this fair came improved techniques in the lighting of foliage and landscaped buildings.

In the 100th anniversary of the independent Lone Star Republic, Texas found ample reason for the Texas Centennial Central Exposition in 1936. Combining the immediate attraction of a well-planned fair with the lasting improvements of a park, a museum, an amphitheater, a stadium, and a giant center for state and regional affairs, this exposition ranked high as a lighting masterpiece. Here, illumination was a major design feature in the nighttime appearance of all buildings. It was considered as an essential element in all plans from the very beginning. Even the interior illumination formed a part of the basic architectural pattern.

As a major contribution to lighting practice, the Texas Centennial demonstrated the value of mobility, of color and brightness as well as the effect of carefully coordinated static patterns.

Fluorescent high voltage cold cathode tubing first appeared on a large scale at the 1937 Exposition International in Paris. Used both in interiors and exteriors, the tubing was formed into delicate tracery of blue, green, and pink. The outlining of the lower structure of the Eiffel Tower was a

notable example. Sodium lamps were employed for some floodlighting, and mercury lamps were widely used for the lighting of trees.

New York and San Francisco, 1939-1940

The year 1939 brought two major expositions, each a milestone in lighting in its own right. Both the New York World's Fair and the Golden Gate Exposition, on Treasure Island, made maximum use of the most complete array of light sources yet available; the new standardized low voltage fluorescent lamp, tubular and projector mercury lamps, and reflector and projector type filament lamps.

In the New York Fair, with its open plot and architectural plan, the lighting was organized to give extensive vistas with unity of character. The plan for color started with white at the Theme Center, radiating in all directions and becoming brighter and more saturated as the distance increased. Floodlighting of surfaces, reflecting and transmitting built-in elements, and mercury lighting of foliage were some of the many techniques employed. Often, luminous elements were used to express the structure of the building. The new fluorescent lamps were exposed in patterns or concealed in coves, coffers, or luminous elements.

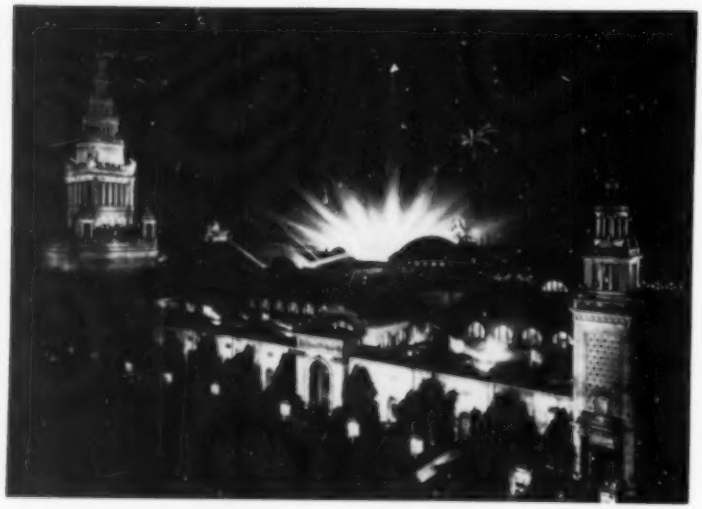
Walled courts flooded with background color predominated at the Golden Gate Exposition. Accents in color, brightness, and pattern were introduced with highlights, shadows, silhouettes, colorful banners, standards, and architectural features. Fluorescent lamps as in the New York Fair played a key part with their brilliant and efficient colors.

From even such a brief resume as this, one inescapable conclusion emerges: since 1893, lighting has played an increasingly important role in each successive international exposition, until, in the late 1930's, controlled electrical illumination in the sense of application as an aesthetic medium had become a dominant element of world's fair design. With lighting so dominant in these influential and trend setting exhibitions, it is not surprising that today's practice bears the stamp of their creative scope. The international expositions have truly been milestones on the road of lighting progress.

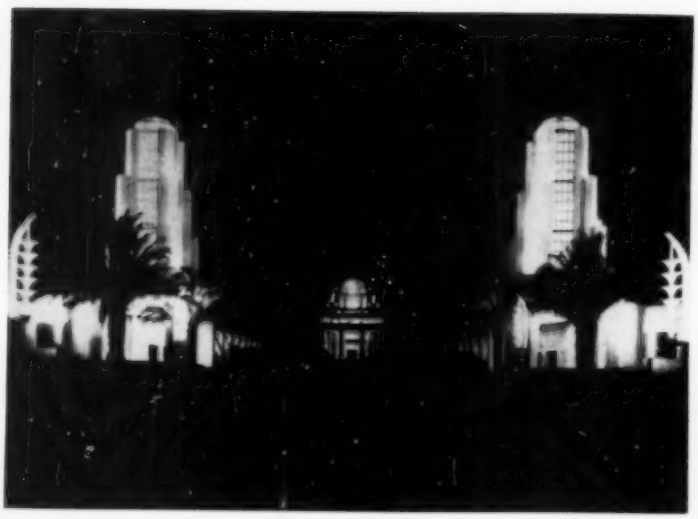
Panama Pacific Exposition, San Francisco, 1915 — From the techniques conceived by D'Arcy Ryan for this exposition, the art of illumination blossomed into an aesthetic expression, foretelling architectural trends which did not come into general practice until more than a decade later. Lighting was no longer an empirical art. It was ready to serve the other arts with definite techniques. It offered exact means for achieving definitely predictable results, both utilitarian and aesthetic. Gas-filled incandescent lamps from 10 to 1500 watts became useful tools; searchlight and floodlight units were made an important part of the ensemble, contributing an essential decorative note.

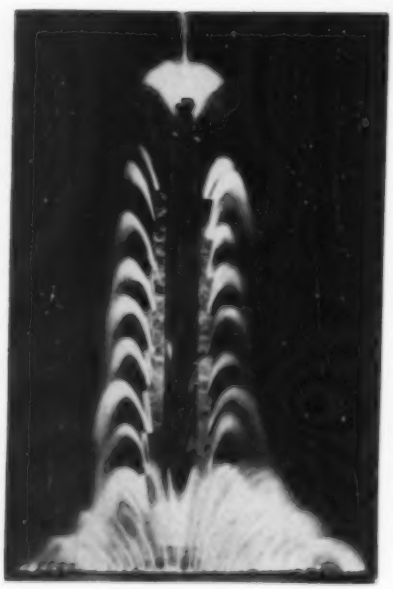
These techniques were forerunners of Future Lighting Practice

Buffalo Pan American Exposition, 1901 — should be rated as an early milestone in the progress of lighting application. The incandescent lamp, hailed still earlier at the World's Columbian Exposition in Chicago in 1893, was for the first time applied at the Buffalo exposition, with a definite decorative technique. Buffalo's Exposition gave to the world large-scale outline lighting, dazzling the public not only with a brighter light source, but giving planned sparkle to the architectural elements, with thousands of brilliant points of light. A most marvelous accomplishment, in those days.



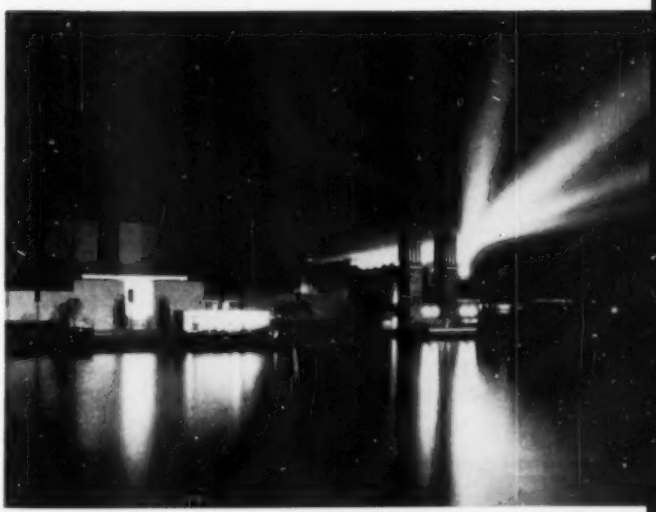
Also at the San Francisco exposition in 1915, many of the buildings were flooded with the pearly, slightly shimmering light of the magnetite arc, and the fabulous Tower of Jewels was lighted by 100 arc searchlights. An innovation in the planning was the setting up of illumination values in advance, as a guide in the lighting design. Values set up were: incidental garden and roadways, 0.1 to 0.25 footcandles; building facades and adjacent lawns, 0.25 to 3.0 footcandles; towers, flags and sculptural groups, 5.0 to 15.0 footcandles.



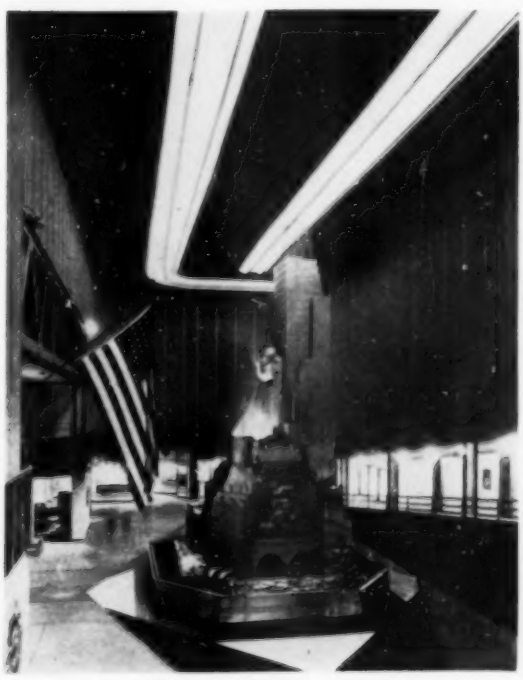


Exposition Coloniale Internationale in Bois de Vincennes, France, 1931. Here, French designers, already known for their ingenuity, created an outstanding fair, having in its architectural treatment, an interesting French colonial flavor. While their method of floodlighting was, by now, conventional, they gave considerable attention to creating exquisite patterns in light and shade (above). Less conventional for those days, however, was their techniques in illumination of architectural fountains, and their indirect street lighting which had considerable influence on later events. Shown at left is the beautiful 200-foot Grand Signal Tower with its feathery spray of water appearing as liquid amber. Still another fountain at this fair was the famous "theatre of Water," modern in form, illuminated in changing colors. The water constantly changed in volume and shape, while shapely figures from the Folies Bergere danced and swayed to the music of a 100-piece orchestra on the stage in the center. Surrounding the lagoon, and on every avenue, were highly imaginative and extremely decorative lighting units.

Century of Progress, Chicago, 1933-1934. It is difficult to estimate the influence of the architecture and lighting designs of this exposition. In general, the idea here was to cast adrift from the past, and follow no previously established pattern. The architecture ran to simple planes, brilliant color, and simplicity in design and honest functioning of the buildings, many of which had no windows. Depression economics of the times were a major influence. Although many visitors to the fair were impressed by the overall effect of the exterior lighting of exhibition buildings and grounds, it still fell short of the resources of the day. It remained for private exhibitors to use the techniques which came nearer to depicting the progress which had already started to gain headway in commercial structures.



An example of the relatively new techniques of combining lighting as part of the architecture, which had already started to gain headway in commercial buildings, was the Chrysler Building at the Century of Progress. The effect was a beautiful picture in lines, form and color, glowing under artificial light. It was evident the night appearance (right) was an early consideration in the building's plans. The slotted recesses, which were patterns of shadow in the daytime, became luminous lines at night. The signs, built in delicate lines of gold gaseous tubing, were particularly fitting in character and brightness, illustrating effectively that such elements were most effective when made a part of the structure. This building was a striking example of a school of thought, introduced earlier, that a building could be designed to present a new picture at night which could be just as satisfying as by day.



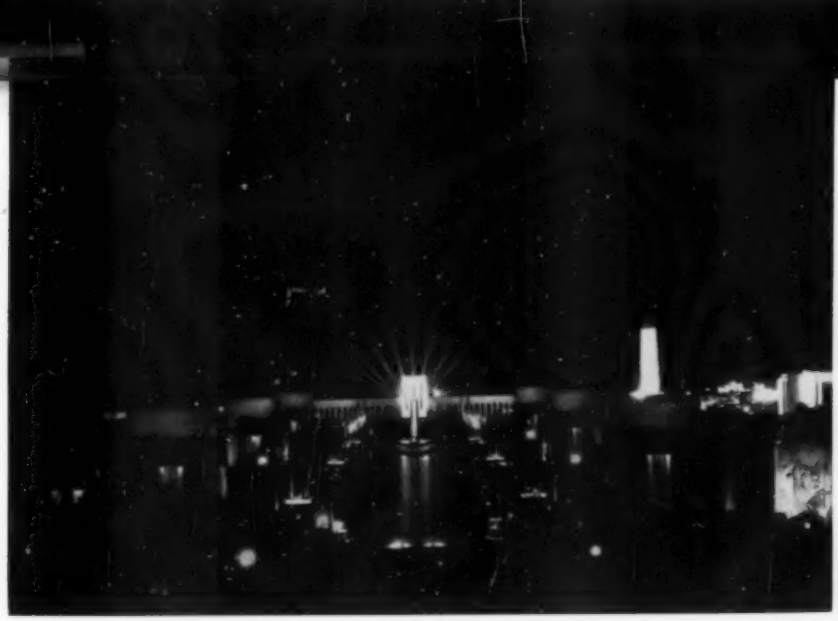
The fact that most of the exposition buildings at the Century of Progress were built without windows gave maximum control of light in exhibits, making possible many impressive and compelling displays. Many of these used the mobility and decorative quality of lighting design to present the most appealing and convincing story to the public — a practice that influenced lighting practice in selling establishments, thereafter. General illumination in the United States Steel Exhibit shown (left) was mobile. In addition, its form suggests what was to come in fluorescent lighting several years later. At one phase of the story, the symbolic monumental composite was spotlighted from units concealed in the ceiling, much as is done in store display lighting today.

These techniques were forerunners of Future Lighting Practice

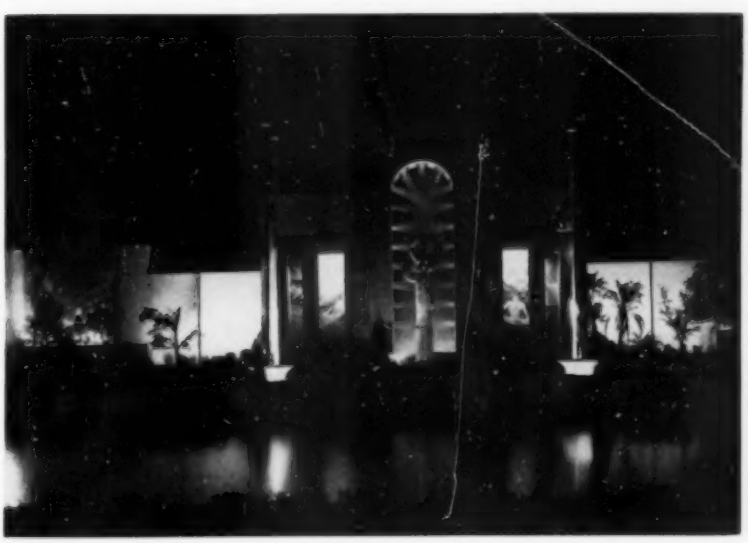
Century of Progress, Chicago

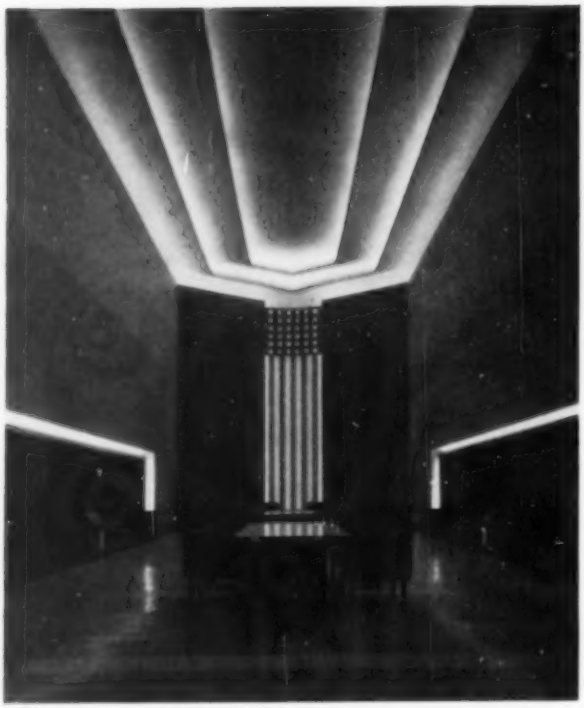
A look at future stores and homes was afforded to viewers of these displays, 23 years ago. Note the now familiar lighting techniques, daringly conceived by lighting engineers who made the most of their opportunity for imaginative design — the more original thinking possible in designing for expositions.

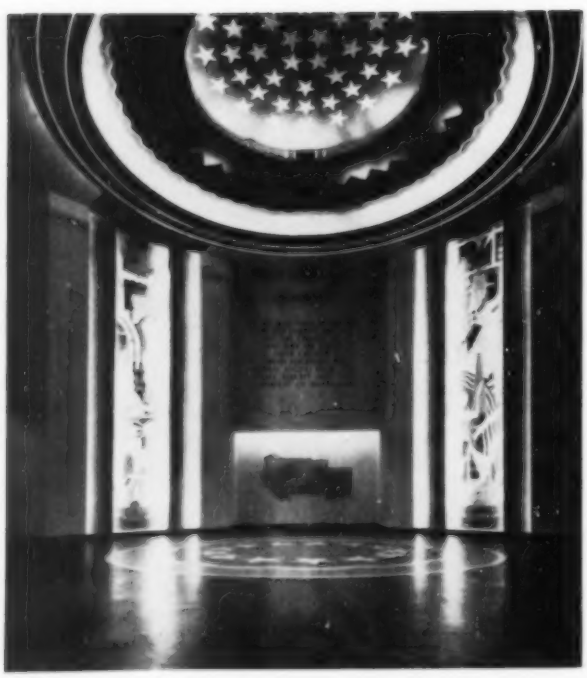
Another forerunner of future lighting practice from the Chicago Century of Progress in 1933 was this private industrial exhibit building which housed a great entertaining and educational display. Complete automobiles were manufactured before the visitors' eyes. The lighting is in character with the prevailing industrial atmosphere. But there was something different. It was the first use of combination mercury lamps with filament lamps on a large scale, producing a general level of 15 footcandles of unusual but satisfactory color quality. A number of other notable contributions to the art of interior illumination were born at the Century of Progress fair, stimulated by the license permitted to imaginative engineers. For example, one building was entirely lighted by hot-cathode mercury and neon tubes.



In 1936 several expositions and celebrations afforded further opportunity to develop forerunners to future lighting practice. Foremost among them was the Texas Centennial Central exposition at Dallas, the opening of which was shortly followed by the Great Lakes Exposition in Cleveland. For the Texas Centennial, the entire exposition was created under a single architect-technical director, and the result was a unit, a coordination, and a finish which evoked deep satisfaction among the most competent critics, as well as every other class of visitor. And, something that should not be missed, they had the good judgment and foresight to realize that lighting was an essential element needing consideration from the beginning, in all plans. The result — a night-time effect which made such an impact that spontaneous editorials appeared in newspapers. Commercial organizations having no connection with the lighting industry, bought full-page newspaper space to pay tribute to the lighting spectacle. Photo above shows the magnificent Esplanade of State. On either side of the long sheet of water rose the sheer, chased walls of six large structures. In front of a niche in each stood a heroic figure (below) symbolic of a flag which has floated over Texas. Connecting these six structures were four large courts, 200 feet across, enclosing the Esplanade on two sides. The stately Texas Building on the third formed the climax in a cloak of white light in contrast to the colorful, breath-taking scenes subtly changing in the great Esplanade. The Texas Building's Crown of Searchlights played over the Esplanade, bringing the composition together and marking the exposition for miles around. In composing the elements in the scene, it was perhaps one of the first instances where brightness, color and size were carefully considered in their relationship to a composite picture.

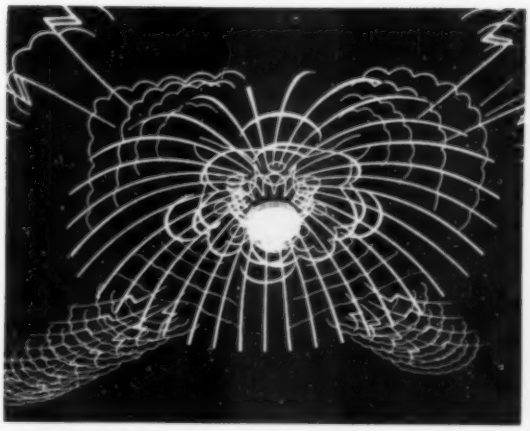


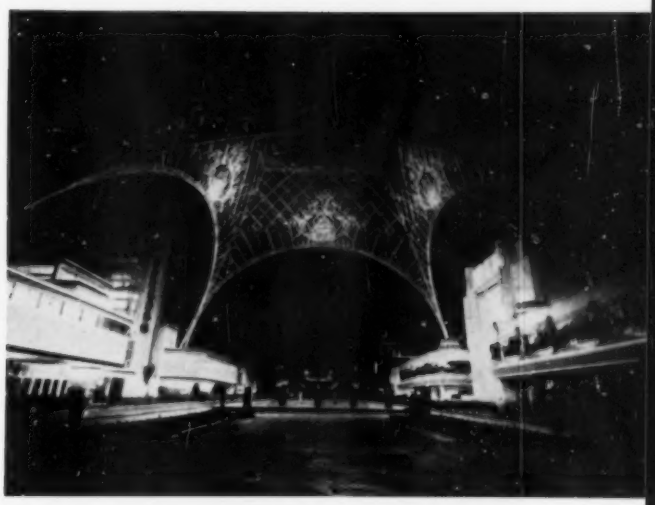




These techniques were forerunners of Future Lighting Practice

Interior illumination at the Texas Centennial was notable for a number of pace-setting techniques. As shown in both pictures at left, the lighting design was an integral part of the architecture, giving expression to the interiors — an extremely fresh concept, back in 1936. The lighting was effectively combined with the decoration and color, also a herald of things to come. Particular attention was given to providing plenty of light for comfortable seeing conditions, in the design for these buildings. The rotunda of the Federal Building was one of the most satisfying examples. The Centennial illustrated the power of mobility of light as influencing the moods of the observer — not as a flow of color from one building or from one unit to another, but more as an intimate scene on a grand scale in which one forgets his worldly cares and brings his imagination into play. No other medium is available to create an equivalent range of sensations to the eye. Several writers at the time said that other expositions will be remembered for their architecture, color and landscaping, but the Texas Centennial will be remembered for its lighting. Actually, lighting became the most featured item of publicity in a show, unusual and appealing, which in itself and as a background, provided many subjects for exploitation.



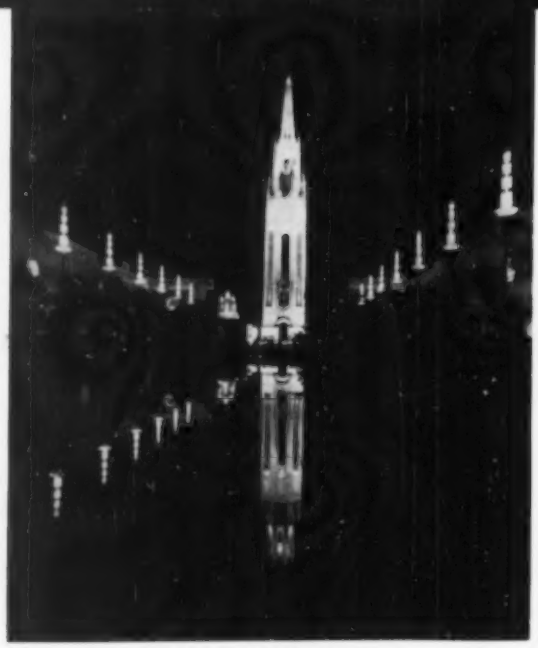


In 1937, Paris again held an Exposition Internationale. While there were many effective lighting treatments, it was here that large-scale use of fluorescent high voltage cold cathode tubing (above) was first featured. This source was employed in both interiors and exteriors. Most of the applications were in patterns formed in tubing with variety introduced in color. Notable examples included the tracery pattern in blue, green and pink for the lower structure of the Eiffel Tower (above right), the simple overall pattern of lines for the facade of the Pavillion de la Radio in delicate blues and greens, and the bold pattern that formed the ceiling motif of the Grand Palais. Sodium was employed for some floodlighting, and mercury lamps had fairly wide usage for the lighting of trees and pylons.

Two major expositions were milestones in lighting in 1939 — the Golden Gate International Exposition at Treasure Island, San Francisco and the New York World's Fair, Flushing Meadows. Foremost amongst the new light sources available to lighting designers was the standardized low voltage fluorescent lamps. New mercury lamps in tubular bulbs and a capillary in a PAR bulb, reflector and projector type filament lamps were some of the others. In San Francisco, the general design combined the beauty and dramatic effect of Oriental and Occidental architecture. The latter plan called for a number of courts forming semi-enclosures which gave opportunity to surround the visitor in

Golden Gate International Exposition

New York World's Fair



Court of Reflections

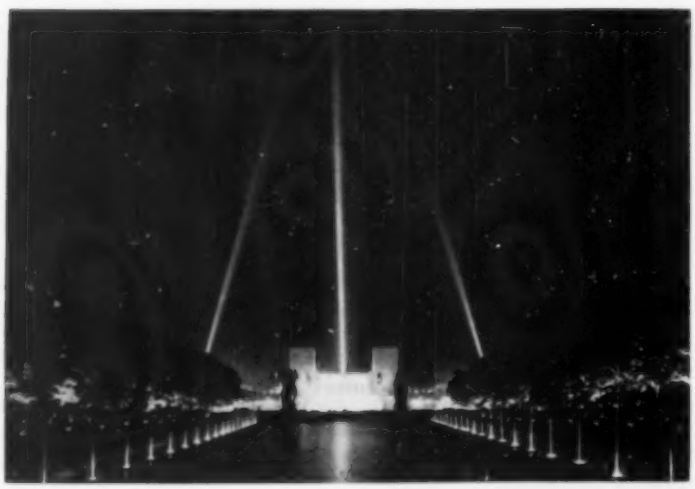
These techniques were forerunners of Future Lighting Practice

Golden Gate International Exposition and New York World's Fair

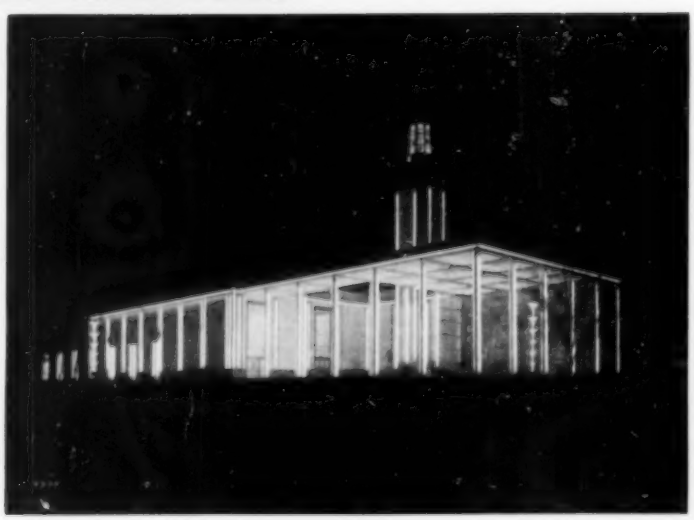
a luminous setting at night, as in the Court of Reflections.

The plan in New York was more open and on a larger scale; longer vistas were in general the rule. On the main axis and all the subordinate axes, the lighting was organized to give a spectacular view with unity of character, as illustrated by Constitution Mall.

The use of light as an architectural element, planned hand in hand with color and structure, was again demon-



Constitution Mall



Netherlands Pavilion

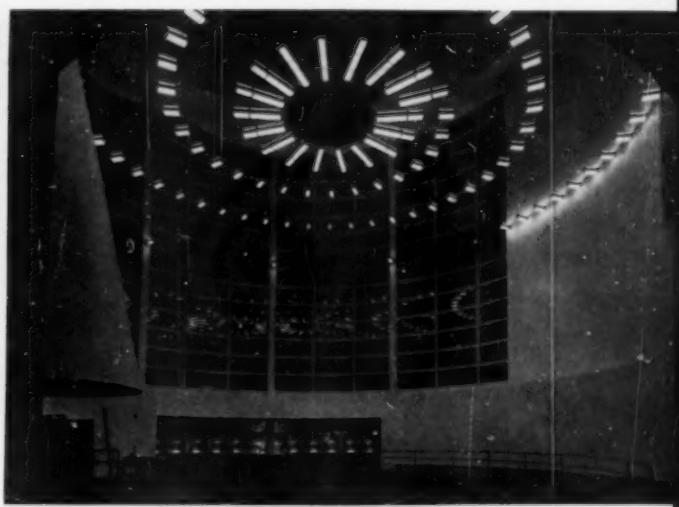
Perisphere

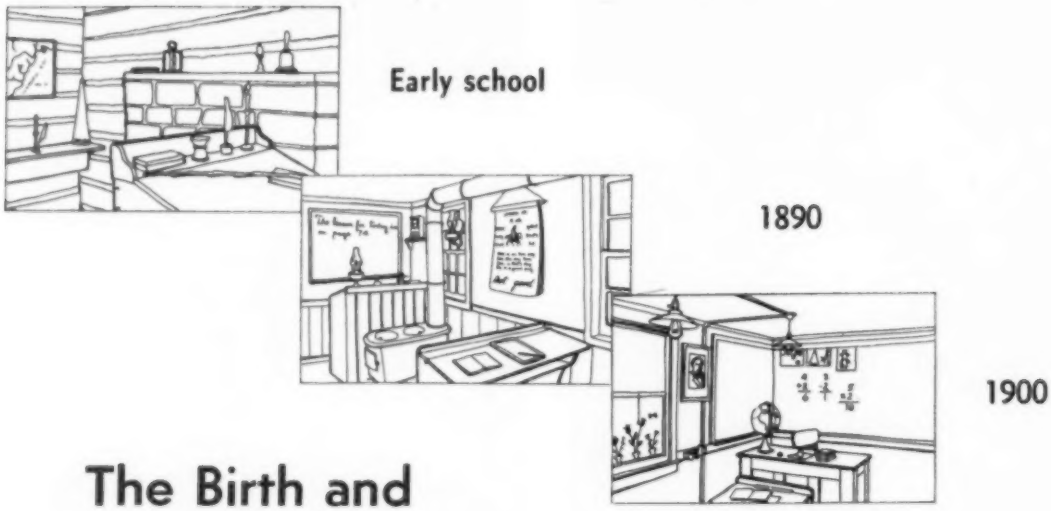
Building using translucent plastic.

strated at the New York fair. Floodlighting of surfaces, reflecting and transmitting built-in elements, light sources used for decoration, were only some of the methods. Often luminous elements expressed the structure of the building, as in the case of the Netherlands pavillion. Still newer effects were obtained with light — projected patterns, in motion, for instance, such as the ethereal effect of the Perisphere seeming to float in space. Other hints of things to come, seen at this fair, included the use of translucent plastics in building structures, wood finishes, corrugated or configurated metals, and glass blocks.

In general, interiors at the New York World's Fair were appropriately lighted. The brand new source — the fluorescent lamp introduced only the year before — was incorporated into lighting designs in a number of ways. Some of the designs used the lamps exposed in patterns (below); other techniques, very new in 1939, concealed them in coves, coffers and luminous elements.

Fluorescent lamps used in patterns





The Birth and Development of School Lighting

THE PERIOD starting roughly from 1900 to the present saw education gradually shift from a process of rote learning through hearing to a process of meaningful education through seeing. This period saw electric light sources increase in efficiency from roughly one lumen per watt to over fifty lumens per watt. During the first quarter century of this period, light was used in the classroom primarily to overcome darkness but by the end of this half century good school lighting was recognized as an educational service. Lighting not only made seeing easier and visual impressions more lasting, but it could establish an environment for more eager cooperation between student and teacher.

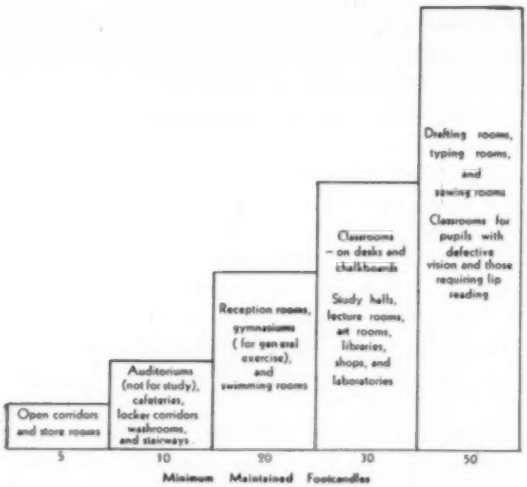
In the period just prior to 1900 educational theory in our school systems was beginning to experience basic changes. To some extent there was interaction between improvements in lighting and the new educational theory, methods, and equipment. In education the transformation came about through the scientific study of education and the advocates of the child-centered schools. The goal was to make the child active rather than passive, to have children work instead of listen, and to learn how to be socially efficient. John and Alice Dewey are recognized as the originators in 1896 of this approach to education.

The year 1900 introduced in Bluffton, Indiana, William S. Wertz's experimental school in which children were led toward adult living through a work-study-play type education. This study indicated a need for group activity type rooms and was to have lasting effect upon teaching methods and eventually upon school construction and lighting.

By the early 1900's technical high schools were being built to include training in the domestic arts for girls and vocations for boys. This phase was coincidental with lighting improvement since such schools became training centers for hobby or vocational work at night by adults. The night classes in many cases exceeded the daytime enrollment and still do.

When the Illuminating Engineering Society was organized in 1906 it was a year of progress in illumination in more ways than one. That year a tantallum incandescent filament was developed which gave five lumens per watt. Within two years a pressed tungsten filament, giving eight lumens, had increased lighting efficiency more than half. Schools were looking at these new light sources as a means of overcoming the teaching slump that occurred on dark overcast days. On these days the teachers had to stop their normal teaching and resort to "make-work" activities.

One of the first reported school lighting re-


Open corridors and store rooms
Auditoriums (not for study), cafeterias, locker corridors washrooms, and stairways
Reception rooms, gymnasiums (for general exercise), and swimming rooms
Classrooms – on desks and chalkboards
Study halls, lecture rooms, art rooms, libraries, shops, and laboratories
Drafting rooms, typing rooms, and sewing rooms
Classrooms for pupils with defective vision and those requiring lip reading
5
10
20
30
50
Minimum Maintained Footcandles

Quantity of illumination. Recommended minimum illumination levels currently in effect. (Approved by American Standards Association in 1948.)

Today

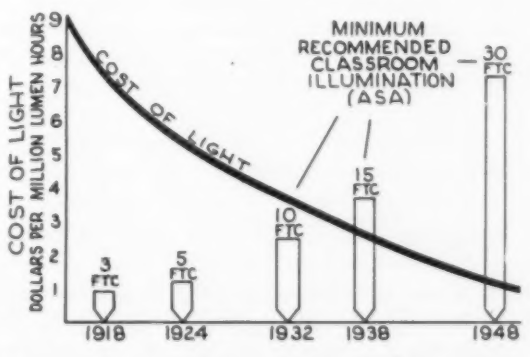
searches was conducted in 1908 in the Knight and Marshall school in Newark, N. J. They were aimed at standardizing the kind of light source, the lighting equipment, the arrangement of lighting, and the footcandles. The sources tested included clear lamps with carbon filament; frosted lamps with graphitized filament, and lamps with tungsten filaments. The lighting equipment consisted of two-arm and four-arm chandeliers arranged in groups of 4, 5 and 9 in typical 22 x 34 foot classrooms. Some of the equipment had reflectors, some had prismatic bowls, some had neither. The tests showed footcandles varying from 2.22 to 3.74.

In 1911 the Proceedings of the Illuminating Engineering Society carried a pioneering article "Conservation of Vision" by Dr. E. M. Alger, pointing out the great amount of eye trouble among school children. In 1912 another article by V. R. Lansingh on the "Value of Illuminating Engineering" discussed good seeing and the prevention of impairment of vision of school children. Interest in how to attain good school lighting was increased in the 1912-1915 period. Major school systems such as Baltimore, Cleveland, Portland and Salt Lake City were conducting lighting surveys of their classrooms to determine where first to make improvements.

At the time the First World War started in Europe, 1914, a report of the British Illuminating Engineering Society showed an average of one to eight footcandles on desks where reading was being done in schools. This was supplemented soon by recommendations that pupils should be able to read common book type at ½ meter — that windows should be on the left — that desks should be no farther from a window than twice the height of the window top — that ceilings should be white and walls light colored — that the wall behind the blackboard should be darker than the rest of the room — that furniture and lower room surfaces should be unobtrusive in color, and that dark shades and black should be avoided.

At the same time in the States, the Luckiesh studies blazed a trail for the many who would in later years add an enormous bibliography on the quality aspect of lighting. His study on "Safeguarding the Eyesight," published in 1915, criticized school lighting for its excessive lamp and fixture brightness, the low position of the chandeliers, and other factors producing glare. Recommendations called for 2.5 footcandles on desk tops, diffusing glassware to reduce glare, a maximum luminaire brightness of three candlepower per square inch, local lighting on blackboards, and the use of semi-indirect units and prismatic direct equipment. As shown by the accompanying cost curve of light, the recommendation of 2.5 footcandles was made at a time when the cost of light was about ten dollars per million lumen hours. This represented considerable progress as in 1900 the cost of light had been 45 dollars per million lumen hours.

The reduction in the cost of light and the greater general appreciation of good lighting were factors in the rapidly increasing use of electric light. The first draft of a School Lighting Code was made by the Illuminating Engineering Society in 1916. Two years later the Society's "Proceedings" carried



Advances in school lighting practice in relation to the cost of light.

these recommendations for lighting school buildings:

	Min. Ft-c	Rec. Ft-c
Classrooms-Libraries	3	3.5 - 6
Fine Shop Work	3.5	4 - 8
Sewing, Drafting	5	6 - 12

By the 1920's the still new electrical industry had improved its power production, equipments, and controls, and had spread a network of wiring to most of the classrooms of the nation. Electrical light was no longer a novelty. But too often school boards and administrators of that era thought of the school as strictly a daytime operation. To them, daytime meant sunlight, with little thought given to daylight's variations seasonally or weatherwise during the day.

In countless schoolrooms the dark days were compensated for by hanging one electric cord in the middle of the school room. The single lamp suspended there might under certain daylight conditions supply the low level of footcandles then considered sufficient, but it would be many years before schools would take the quality, as well as quantity of lighting into serious consideration.

It is not surprising then that the F. C. Caldwell paper, "Good Lighting in Schools," in the Proceedings of 1920 pointed out an increase in eye defects, the visual difficulty encountered in seeing certain school tasks, and the lack of sufficient illumination as one of the factors back of visual troubles.

In 1922 H. B. Dates' "Practical Application of Principles of School Lighting," based upon tests in Cleveland, Ohio, schools, showed that six outlets per room gave superior distribution of light as compared with four. The average illumination level found in the schools ranged from one to two footcandles. He recommended four to eight. He suggested setting standards for enclosing globes as to efficiency, distribution, and brightness. By this time a revised School Lighting Code was well under way, and in 1924 it was published as approved by the Illuminating Enginering Society, the American Institute of Architects, and the American Standards Committee. Its recommendation included:

	Minimum	Recommended
Footcandles in Classrooms	5	10
Libraries	3	6
Manual Training	5	10
Drafting Sewing	8	15

The new Code offered practical data about lighting layouts, gave the lumen output of lamps, the coefficient of utilization of lighting units, brightness values and other information, including recommended types of equipment. Popularized drafts of the Code were published in 1925 by the Eye Sight Conservation Council and the National Council for the Prevention of Blindness.

During these years of improvement in standards for electrical lighting of classrooms, little had been done by comparison in the study of daylight. In 1926 Clark and Beale of the U. S. Public Health Service published "Daylighting in Schools" followed soon by Beal's "Factors Affecting Daylight Lighting of Interiors" which reported upon studies in applying daylighting to schools.

By this time four states were following the I.E.S. Code, and 14 more promised to cooperate in applying its principles. The I.E.S. Committee of Public Service Information referred to poor lighting which did not follow the Code, and pointed out that poor lighting conditions were probably back of much defective vision.

A revised I.E.S. School Lighting Code, approved by the American Standards Association in 1932, reflected increasing recognition that former levels of lighting intensity had been too low, and recommended 12 footcandles in classrooms, with a minimum of 10. The types of equipment recommended were general diffusing enclosing globes, and indirect and semi-indirect luminaires. The I.E.S. Proceedings of this year reported the results of a two-year test in Tuscumbia, Alabama using photoelectric cells to control illumination level.

The I.E.S. Committee on School Lighting was also at work on a lamp for study at home, to furnish good lighting with comfortable quality. This resulted in the I.E.S. study lamp which was announced in 1933. The specifications were made available to manufacturers of table and floor lamps and they were widely used.

In 1936 a full scale demonstration classroom was installed in the Lighting Institute at Nela Park. This room demonstrated to the public the need for good lighting in schools and stressed the importance of comfortable quality illumination. A report upon tests in the Cambridge, Massachusetts schools by Willard Allphin indicated that students in well-lighted rooms showed 28 per cent improvement in reading and 10 per cent better achievement. During this period the Department of Education, State of Ohio, reached conclusions among others, that schoolrooms should have a minimum of 30 footcandles, that the light should be well diffused, and that direct and specular glare should be well controlled. This emphasis on quality was evidence that the illuminating engineer had ceased to function as a mere supplier of raw light. He was now becoming a consultant on all the environmental factors which in combination affected good effi-

cient seeing. Special lighting on "blackboards" was being recommended and many experiments were being made with boards of different composition and in various color combinations of board and chalk.

The "New American Practice of Lighting Schoolrooms," 1938, recommended:

Classrooms	15	footcandles
Shops, labs and sewing rooms	25	"
Gyms	15	"

By '38 the "new" fluorescent lighting was attracting much attention among school planners. It brought out discussion and even argument among school people because of the color and flicker of the early lamps. Some ophthalmologists felt that fluorescent was sending them a new crop of patients. This led to studies by the American Medical Association which subsequently published an endorsement of good quality fluorescent lighting. The advent of this new type of illuminant opened the door for the relighting of America's schools. It permitted substantial increases in classroom illumination without requiring major rewiring programs.

The Luckiesh-Moss report of 1940 on tests at the University of Missouri where footcandles ranged from 25 to 40 showed improvement in educational age when the students studied under higher illumination than was common at that time. Also in 1940 the Darley-Ickis "Chalkboard Visibility Tests" demonstrated the principle of highest visibility when contrast between board and chalk is greatest.

In 1942, the Medical Women's Journal published the Harmon preliminary observations on the developmental problems of several thousand Texas elementary school children, presented earlier to an IES sectional meeting. He reported a close relationship between lighting and the child's physical as well as educational development. ILLUMINATING ENGINEERING published the Biesele-Folsom-Graham report on "Control of Natural Light in Classrooms," covering one of the early Harmon demonstration centers.

By 1944 World War II was well advanced and the I.E.S.'s school lighting recommendations were being accepted in connection with the operation of V-12 classes. The spread of fluorescent lighting, which had been introduced shortly before the war started, was curtailed during the war years, but study and development continued, so that by the end of the war in 1945, it had passed its tests and had burgeoned into widespread acceptance.

Recognition of the relationship between education and lighting came from the National Education Association in 1946 in the form of "Teaching About Light and Sight" which had been in preparation during the war years. It was a handbook for teachers in elementary and secondary schools, and included information about light as related to sight in school and home, the I.E.S. standards, and suggestions for teaching pupils the fundamentals.

The years '46 and '47 were notable also for such Society publications, related to school lighting, as Allphin's "Brightness Control in Model Classrooms" where fluorescent was the illuminant; Biesele's "Integrated Lighting for Classrooms," with emphasis on integration of all classroom elements rather than stressing footcandles; the Darley-Taylor study, "Lighting of Cadet Barracks in U. S. Military Academy at West Point"; the Turner Brainerd studies of classroom brightnesses, chalkboards, and other environmental features brought out in "Classroom Fields of Vision"; Putnam's "Quality Lighting in Schools," based upon tests at Oxford School, Cleveland Heights, Ohio which included recommendations, among others, of colored chalkboards of 20 per cent reflectance; the Gibson "Conditioning Schoolrooms for Visual Comfort and Efficiency" which, again, emphasized brightness controls and balance; and the Harmon "Light on Growing Children" in *Architectural Record*.

These are examples from the mass of evidence, accumulated by the late '40's, that the study of vision and school lighting have gone hand in hand increasingly. Findings pointed more and more to the necessity for higher levels of illumination than had been recognized when the Society was young, and to the additional necessity of controlling light for quality. The new I.E.S. and A.I.A. "American Standard Practice for School Room Lighting," approved by the ASA in 1948, called for a minimum of 30 footcandles in classrooms and 50 for drafting and sewing, with other brightnesses carefully controlled throughout the room.

The same year, the Better Light Better Sight Bureau issued supplementary teaching materials for use by teachers in the fourth, fifth, and sixth grades, and the National Council on School House Construction published its "Guide for Planning School Plants" which contained lighting recommendation for adequate visual acuity and comfort.

The Better Light Better Sight Bureau in 1949 expanded its work among teachers by issuing teaching materials for the seventh, eighth, and ninth grades in science classrooms, and this was extended to include home economics classrooms from the seventh to twelfth grades.

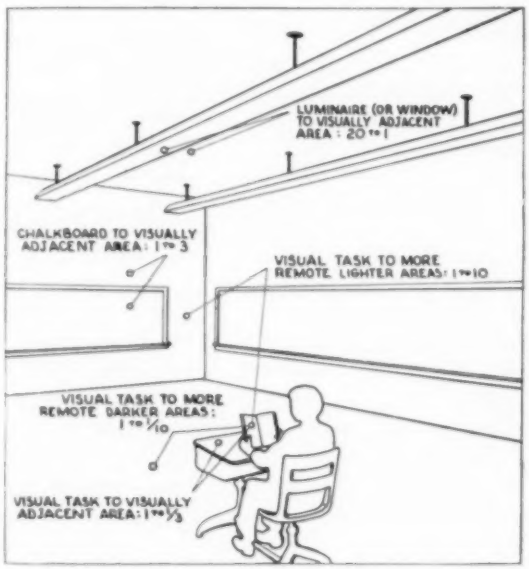
In the beginning of school lighting a chief concern was the demonstration of the needs for adequate quantity of illumination. By 1950 this need

was generally recognized by school administrators and good quality lighting was being installed as fast as school funds permitted. The combined efforts of I.E.S., other professional societies, educational and school planning organizations, lamp and lighting equipment manufacturers, governmental and private health education groups, the trade organizations such as electrical contractors, as a few examples, have not only raised lighting in schools to safer levels, but have also gained wide acceptance of the importance of good quality lighting.

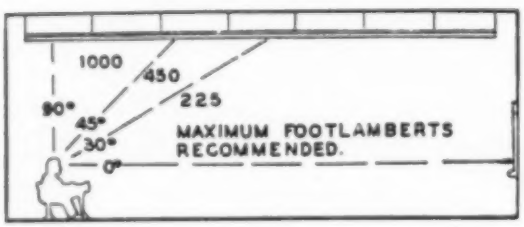
Over the past half century, progress in understanding of the educational processes led to changes in curricula and methods. Progress in school plant design, the control of space, light, temperature, humidity, furnish examples of the other forces which also have exerted powerful influences upon education. In the earliest stages of the era, illuminating engineers specializing in school lighting thought primarily of lamps — then, as lamps were improved, fixtures and finally correct light for the eyes of children.

Quality Recommendations Today

Limiting brightness ratios (right) recommended by the American Standard Practice of School Lighting.


LUMINAIRE (OR WINDOW) TO VISUALLY ADJACENT AREA: 20 to 1
CHALKBOARD TO VISUALLY ADJACENT AREA: 1 to 3
VISUAL TASK TO MORE REMOTE LIGHTER AREAS: 1 to 10
VISUAL TASK TO MORE REMOTE DARKER AREAS: 1 to 1/10
VISUAL TASK TO VISUALLY ADJACENT AREA: 1 to 1/3

Current recommendations on limiting brightnesses of school lighting luminaires (below). The American Standard Practice of School Lighting permits doubling these values if the bright areas of the luminaire are small and the room is finished in accordance with recommended reflectances.



Numerous studies of vision and its relation to school lighting, conducted during the thirties and early forties, pointed to the need for higher levels, and the necessity of controlling light for quality. In thousands of classrooms desk tops, wall and floor surfaces were lightened, and the familiar blackboard was replaced with green "chalkboard." The recommended level of 30 footcandles, and limiting brightness recommendations were adopted as School Lighting Codes in many States.

Developments in School Lighting Techniques

During the school days of most mid-century I.E.S. members, open-bottom glass cones over 100-watt lamps, dimly dispelled the darkness and provided uncomfortable spots of brightness in the field of vision. Though representing typical school lighting practice before World War I, this picture was, ironically, taken only recently.

Enclosing glass globes were widely used in classrooms during the early twenties, often only two per room. Typical also is the indifference to daylight control and the circumstance of leaving the electric lights off on a "bright day."

Very low levels of illumination, of the order of two or three footcandles were standard practice in the twenties. Illumination on the vertical plane in this typical school library would be virtually unmeasurable.

Same library as the previous photo. The development of semi-indirect diffusing luminaires with higher wattage lamps and closer spacing brought a marked advance in lighting levels and visual comfort. The concept of balanced brightnesses had not yet appeared, however.

Various techniques have been developed in recent years for the application of modern school lighting concepts. In this installation, fluorescent lamps mounted flush to the ceiling are shielded from the normal line of view by suspended baffles also having acoustical properties.

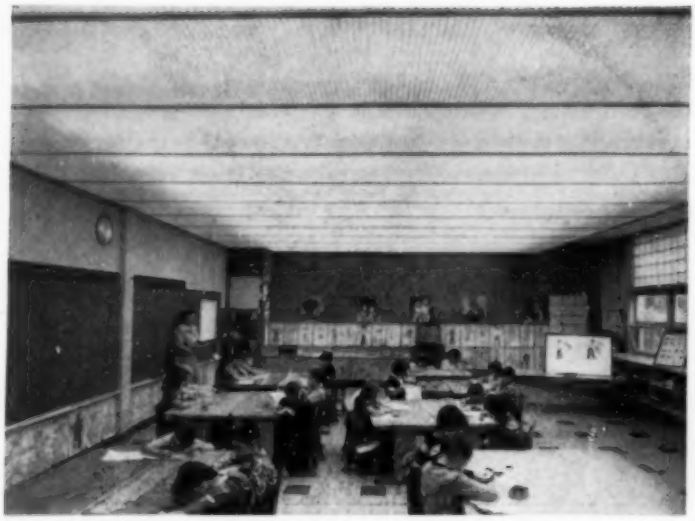
Recessed troffers with prismatic glass shields provide illumination of the order of 50 footcandles in this contemporary classroom area. Swivel spots highlight the artwork on the vertical surfaces. Note the trend to light colored surfaces.

Developments in School Lighting Techniques

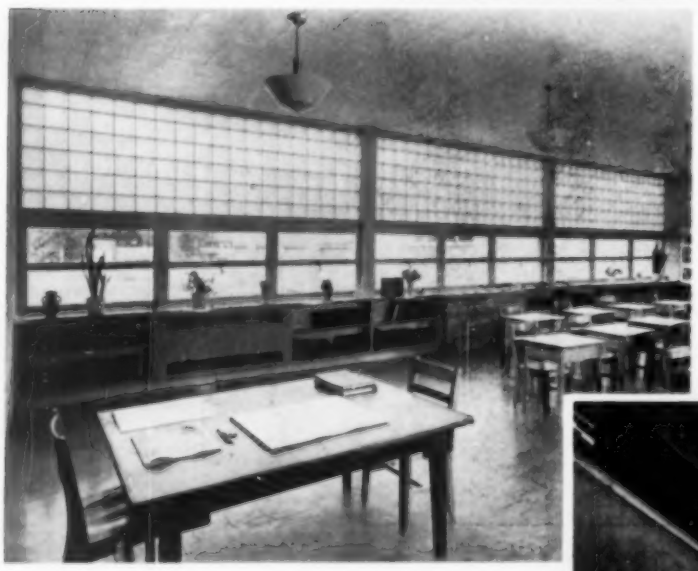
Three continuous rows of suspended louvered units in an elementary classroom.

Continuous rows of luminous indirect luminaires in a kindergarten.

Concentric-ring luminaires of aluminum, shielding silver-bowl lamps, are widely used in current practice.



Modern first-graders under a luminous ceiling of vinyl plastic.



Daylight control, acoustical ceilings and light surfaces throughout are now accepted practices in many current schools. In the room above, light-directional glass block with vision strip is used along one entire wall.

High levels of illumination (approximately 100 ft-c) from supplementary units mounted above the board are a modern trend.

Developments in School Lighting Techniques

The old and the new in corridor lighting is graphically demonstrated in this school installation. In the extension of the corridor in the background, widely spaced enclosing globes have been replaced with a continuous row of fluorescent units.

Educational systems of 1956 call for classroom areas undreamed of when I.E.S. was young. This is a typical exhibit room, in this instance an alcove off a corridor, set apart by the use of semi-recessed spotlamps, adjustable for various types of display.

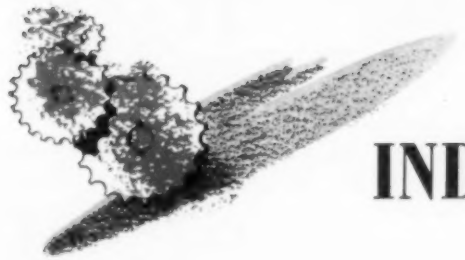
Modern gymnasiums require flexible systems to provide levels varying from a few footcandles for dances, to 50 to 100 ft-c or more for basketball games.

Developments in School Lighting Techniques

Band room is standard with new schools. Such an area requires a lighting system that can be viewed comfortably from almost every angle.

Home economics room, circa 1956. Deluxe fluorescent lamps have been used for best color rendition to foods and fabrics.

The school lounge is another modern "must" with many schools. This area is frequently used at night for community as well as school activities. Recessed domes with silver-bowl lamps provide general lighting; portable lamps and adjustable spot units serve a decorative purpose in this room.



INDUSTRIAL LIGHTING

THROUGHOUT the years, I.E.S. has been a major influence in the progress of industrial lighting practice. Figuratively speaking, the ink was scarcely dry on its By-laws when a committee was appointed to study this important phase of lighting.

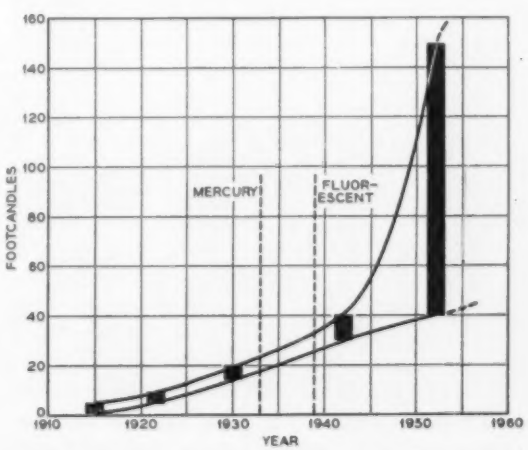
The first I.E.S. industrial lighting code was prepared in 1915. This offered the first official guidance to lighting levels and techniques for factories. The levels recommended in those days reflect, of course, the practical limitations of the light sources and equipment available. Surprisingly enough, however, many lighting engineers were far in advance of general practice of their day. Even before researches in lighting and vision disclosed scientific reasons for balanced brightness ratios, many early illuminating engineers were recommending what would now be termed "quality" in their lighting installations. It was to be many years, however, before these few early voices were generally heeded, in regard to lighting techniques for quality.

A new, revised recommended practice for lighting "factories, mills and other work places," still termed a code, was published by the Society in 1921. A little more knowledge on what was needed, a few more advances in equipment and light source design, were the basis for the recommendations of the 1921 Industrial Lighting Committee. (See Chart.) Although the footcandle levels recommended seem strange in the light of current knowledge on light and seeing, this code nevertheless represents another step in the right direction. Considerable emphasis was given to maintenance of the lighting system and a whole chapter was devoted to "The Avoidance of Glare." This Code was approved, in December 1921, by the American Engineering Standards Committee, to become the first approved Standard for Industrial Lighting.

In the revision of it, published in 1930, still further emphasis on avoidance of glare was a feature, including tables for rating light sources from the glare standpoint. Quality, as we know it in 1956, was still to come.

By the time the next American Recommended Practice of Industrial Lighting was published in May 1942, the practical advantages of good industrial lighting were very widely appreciated, and the Illuminating Engineering Society was the recognized authority for information on it. Tens of thousands of the 1942 Practice were placed in the hands of factory managers, production personnel and others — for plants both large and small. Many thousands of these were distributed by the Labor Department of the United States Government, endorsed by that body, and printed with a cover of their own design and title. Still further thousands were similarly sent out by the Department of Labour and Defence of the Canadian Government, each with the suggestion that I.E.S. lighting recommendations be applied in all factories, to aid in the increased industrial production needed for the war.

Current practice for industrial lighting is outlined in the American Standard Practice for Industrial Lighting, approved by A.S.A., and published in August 1952. The techniques of lighting application in industry had advanced considerably in



Recommended levels of general illumination for industrial areas — I.E.S. recommendations.

Typical of 1907 industrial lighting is this automobile body assembly plant. Lighting is from four-mantle gas lamps, one every other bay.

the intervening years. The I.E.S. committee which developed it had for their guidance new studies on brightness relationships in the illuminated environment, the introduction of many new light sources, and much experience gained in the use of previous recommendations. Its value to industry is widely recognized — and it, too, is well into the tens of thousands in its distribution. As with other I.E.S. committees, the group devoted to the study and report of industrial lighting has throughout the years been a dynamic factor in carrying out the Society's aim ". . . for the advancement of the theory and practice of illuminating engineering, and the dissemination of knowledge relating thereto."

Plant layout and lighting in 1907. Enclosed arc lamps (flaming arc lamps) were used in this machine assembly area. The lamps had to be trimmed and carbons replaced every 16 hours; each carbon cost 16 cents.

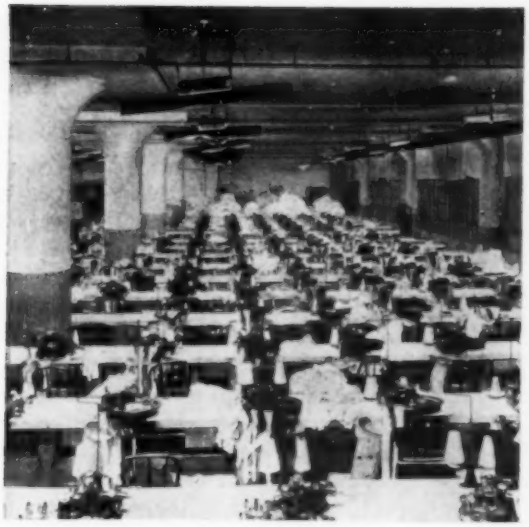
Significant Developments

Fifty years ago most of the lighting in steel mills, textile mills, and other high-mounting industrial areas was from carbon arc lamps placed high above the work area. In other industrial areas at lower mounting a variety of sources and techniques of application were in use. In an automobile body assembly plant, for example, the lighting consisted of four mantle gas lamps, one every bay. In a motor assembly plant, enclosed arc lamps were used. The d-c Cooper-Hewitt mercury lamps, introduced about 1903, and the a-c mercury lamps, about 1906, were first employed for photographing and photoengraving purposes. In the period following 1908, however, they began to replace carbon arc lamps in the textile industry. At this time these lamps used the manual tilting method of starting. In other industrial areas, such as machine shops, bare carbon filament lamps (16-cp, 4-50 watt) suspended on drop cords and positioned close to machines or work benches were generally used; there was no general lighting system as such. Higher efficiency tantalum (1906) and pressed tungsten (1907) filament lamps were introduced in this era, but because of their fragile filaments they failed to gain wide acceptance as replacements for carbon filament lamps.

A cost comparison of three different light sources for a 3-footcandle installation was published (1907).

Source	Initial Cost	Maintenance Cost	Power Cost	Total Annual Cost
Mercury Vapor lamps..... (Cooper-Hewitt)	Low	Low	Low	$236.96
Metalized filament clusters	Low	Low	High	$409.06
New arcs (flame arc).....	High	Medium	Low	$366.24

The year 1909 marked the beginning of general lighting installations using filament lamps. Lamps were placed in radially fluted street lighting units and pulled up away from the immediate work area. A typical "pace-setter" installation for a machine shop was a 100-watt tungsten filament lamp (80 cp) in the radially fluted unit suspended from the center of each 20-foot by 20-foot bay. This produced about one footcandle, maintained. Additional local lighting, usually employing the more rugged carbon filament lamp, was, of course, necessary. Lighting recommendations in this era included replacing the unsightly drop cord system with a tungsten filament general lighting system, plus local lighting on arms attached directly to the machines. A further refinement about this time was the addition of some sort of shield over these lamps.



A 1908 textile mill used Cooper-Hewitt mercury vapor reflectors. The units, which had to be tilted, were rotated at an angle of 30 degrees to provide light from the rear of the operator.

Typical early industrial installation using the "new" incandescent lamp. The process for drawing tungsten wire increased filament strength, and unshielded lamps of up to 100 watts were used for general lighting.

With the development of the process for drawing tungsten wire (1911) filament strength of the tungsten lamp was greatly increased. A movement toward replacing the older type carbon, tantalum, and pressed tungsten lamps grew rapidly. General lighting took a firm foothold, using drawn tungsten filament lamps of up to 100 watts. From the standpoint of objectionable glare this was about the limit in wattage for unshielded lamps.

The trend toward general lighting installations of the 100-watt variety and the development of the more efficient, concentrated filament, gas filled lamps (1913) brought with them the need for better shielding and control of lamp output. A shallow dome reflector was developed for use with the vacuum type lamps, and a deep bowl reflector was designed to provide better shielding for use with the higher brightness gas filled lamps. Also during this period the mercury vapor quartz lamp was introduced (1913). Its main advantage over the long tubular mercury source was its small size, made possible by the use of quartz with its higher melting point. Its life rating was in excess of 8000 hours. With improved end seals it was hoped that the lamp life could be increased to that of the long tubular source which had been known to run as long as 60,000 hours.

Up to the beginning of the first World War the general lighting level grew to the 3 to 5 footcandle range, with additional light from local lighting units. The total nation-wide incandescent lighting load had surpassed the total load of the carbon-arc type installations about 1914. In machine tool industries before the war the local lamp idea, involving mounting lamps directly on the machines, also gained in popularity. A metal shade, usually half-pear-shaped, was placed over the lamp to control direct glare.

World War I in 1918 brought with it an urgent need for increased production and longer working hours, sometimes involving multiple shifts of workers. General lighting in machine shops and production areas increased from about 4 to 7 footcandles, and sometimes as high as 10 footcandles! Lamps of 200- and 300-watt size were being installed on 10- to 14-foot centers. As early as 1917 luminaires were mounted on disconnect hangers for ease of maintenance. The inadequate shielding of the shallow dome reflector, and the gloomy appearance and low vertical surface illumination resulting from the deep bowl reflector, were now quite apparent.

In 1917 and 1918, "productive intensity" tests were made in higher footcandle ranges (12 to 20 ft-c), which brought out the need for better shielding with better lighting equipment, and led to the conclusion that higher levels of illumination could increase production. Several lighting equipments were proposed for this purpose, one of which included a shallow reflector with a cylindrical shield suspended around the bare lamp. Shortly afterward the RLM Dome industrial reflector was introduced (1919) and a bowl enameled lamp (1920)

Some of the principles of illuminating engineering were beginning to be applied in this early installation in a printing plant. Flashed opal glass transilluminated with incandescent lamps, for type setting.

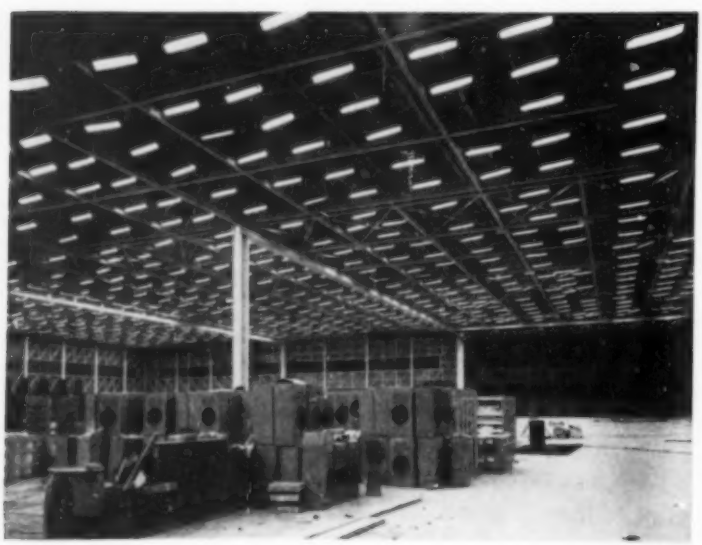
was developed for use with it, the combination of which gained wide and rapid popularity for general lighting in industry. The RLM Dome and bowl enameled lamp with better shielding and vertical surface illumination was a great step forward in the industrial lighting application field, and was probably the largest single factor in placing filament lamp installations in an advantageous competitive position with the Cooper-Hewitt mercury source.

As better general or overhead systems of lighting were adopted, the practice of localized lighting of machines and benches began to lose ground. There was rapid elimination of the unsightly drop cords and of the necessity for changing the location of outlets with each change in the arrangement of machines and work benches. Filament lighting in textile and paper mills was meanwhile beginning to replace the carbon arc. Typical installations of this era consisted of 50-watt lamps on 15- to 20-foot centers. The trend toward higher illumination levels is reflected in State recommendations of from 2 to 12 footcandles.

Following the war, industrial personnel and lighting application engineers were becoming much more conscious of the quality of lighting. They stressed the careful selection of reflecting and diffusing accessories necessary for the general lighting system, and recognized the importance of proper distribution of illumination, better utilization of flux, minimum glare, and softer shadows. However, they also formulated a false idea that they could dispense with local lighting altogether because of the higher general illumination (10-20 ft-c) which could be obtained with the bowl enameled lamp in the RLM Dome reflector.

In the very early twenties the glassteel diffuser unit (1921) was developed. This made possible wider use of the 300-watt size lamp without objectionable brightness (same brightness as present-day bare fluorescent lamp). Illumination levels steadily rose to the 20- and 25-footcandle level during this decade, employing generally the glassteeel diffuser and the glass top dome units.

About 1924 there was a realization that a 20-foot-



During World War II, acres of space had to be illuminated day and night, a major challenge to industrial lighting practice. This 1941 airplane factory used RF type fluorescent lamps. Note that the units had to be tilted slightly to facilitate starting.

Some Industrial Lighting Systems

ARC AND MERCURY VAPOR LUMINAIRES

1878
OPEN ARC

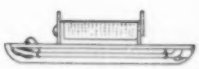
1893
ENCLOSED ARC

1903
LUMINOUS ARC

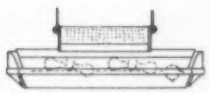
1903
TILTING
COOPER HEWETT

1908
FLAME ARC

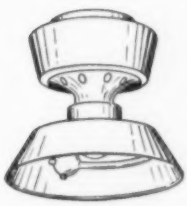
1913
ENCLOSED
FLAME ARC



1920
COOPER HEWETT



1930
COMB. COOPER
HEWETT



1935
CIRCULAR COMB.
COOPER HEWETT

FILAMENT LUMINAIRES

1890
DROP CORD

1895
CONE SHADE

1900
SERIES LAMPS

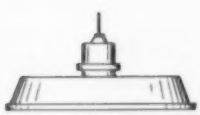
1905
FLAT CONE

1910
DEEP BOWL

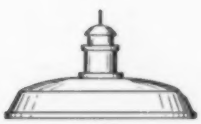
1914
PRISMATIC

1915
MIRROR

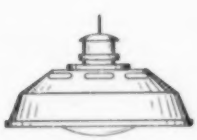
1916
SHALLOW
REFLECTOR



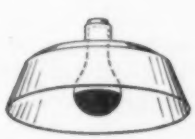
1918
DISHPAN



1920
RLM



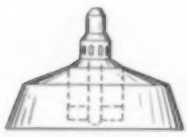
1925
GLASSTEEL



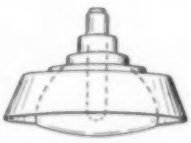
1939
SILVER BOWL
DIFFUSER

Some Industrial Lighting Systems

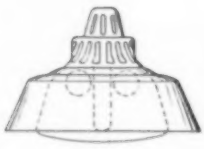
MERCURY DISCHARGE LUMINAIRES



1934
400W MERCURY
DOME

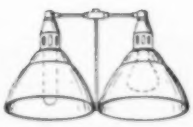


1935
400W MERCURY
DIFFUSER



1935
400W COMB
MERCURY

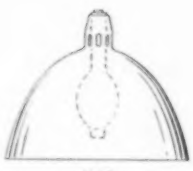
1938
400W MERCURY
PRISMATIC



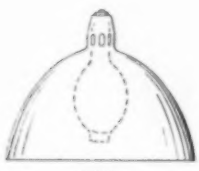
1939
400W TWIN COMB
MER + INCAND

1940
3KW MERCURY

1950
1000W MERCURY



1953
700W MERCURY



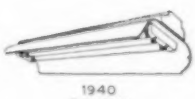
1953
COLOR-CORRECTED
MERCURY

FLUORESCENT LUMINAIRES

1939
100W RF

1939
2-40W
TYPE F

1940
2-40W
RLM

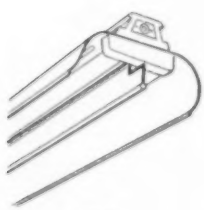


1940
3-40W
RLM

1942
2-100W
RLM

1947
2-40W BAFFLE
RLM

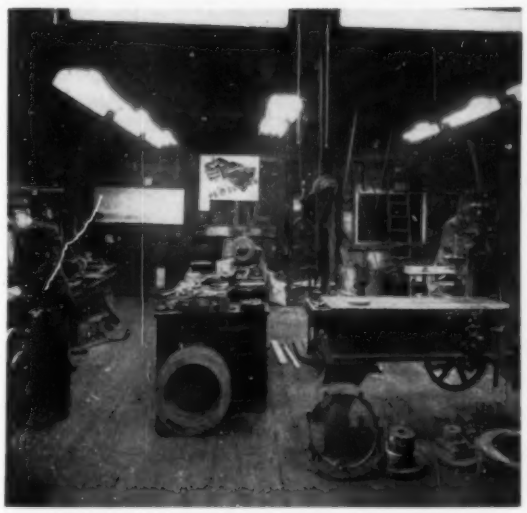
1951
2+3-40W
AND 2-90W SLIMLINE
10% UPLIGHT



1951
2-40W
BAFFLE + SLIMLINE
10% UPLIGHT

1954
2-40W + SLIMLINE
25% UPLIGHT

1954
2-40W + SLIMLINE
LOUVERED
25% UPLIGHT



An interesting transition is illustrated in three different eras of lighting practice for the same shop, in these three pictures of the J. L. Sparling Company.

(A) (above). The original lighting consisted of one lamp in a ceiling fixture for general illumination, and another bare lamp over the machine for local lighting. Lack of shielding is typical of the period.

(B) (above right). The area has been "relighted" but with the addition of more lamps, still bare.

(C) (right). Relighted with fluorescent closed top industrial fixtures. Illumination is now 50 footcandles, but in light of current practice, the installation is still far from good.

candle general lighting system alone (no local lighting without any regard to the placement of machines and work tasks was not sufficient. Two schools of thought developed for remedying the situation:

1. Group lighting (localized general lighting), where the general lighting system is located with respect to the machines and work tasks instead of with respect to the bays.
2. General plus local, where the general lighting system is located with respect to the bays, and local lighting is added at the machines or work tasks.

Automotive industries were good examples of the general plus local type of lighting. Group lighting was used in stamping plants and body plants, and in the South in most textile mills.

In the late twenties some thought was given to inspection lighting techniques. For one thing, the proper inspection of polished surfaces has always presented difficult problems because of the regular mirrored reflections of all light sources from the surface being inspected. Several types of inspection boxes or booths were developed to solve this problem.

More stress was placed on increasing illumination during the thirties than at any other time in lighting history, probably stimulated by the tests undertaken at that time on the relationship of more light to better seeing. By the end of the decade, a good general lighting system was considered to be on the order of 30-35 footcandles.

Also, during this era the high pressure mercury arc lamp was introduced (1932) for use at the higher mounting heights. Thus higher levels of illumination were made possible with the same or fewer numbers of lamps.

In 1936, the I.E.S. Industrial Lighting Committee embarked on a "project" program. Heretofore

First "grid" system; used first in 1945 at the New York Trade School.

lighting for specialized industries varied with the individual ideas of the particular person designing it, and sometimes at great expense to the industry. The committee gathered information from a variety of sources and analyzed the problems involved in each specialized type of work. They then prepared project reports for lighting of these areas to acquaint the lighting designer with the important problems peculiar to each, and to guide him in his lighting recommendations. The first project report, on the printing industry, was published in 1936. It contained an analysis of what the critical seeing environments were, and suggested lighting solutions for them. For example, flashed opal glass transilluminated with incandescent lamps was suggested for setting type. Some of the other reports which followed included lighting for the grey goods industry, machining of small metal parts, heavy machines, and citrus fruits and the packing industry.

An early example of high levels for industry was in the Milwaukee Journal printing shop. The installation provides 110 footcandles, with 180 over the classified make-up section.

With the development of the fluorescent lamp (1938) the outlook toward better quality lighting at higher illumination levels was brightened. Because of its comparatively high cost, however, fluorescent lighting was not generally accepted by industry until just before our entry into World War II. During the war, increased production was paramount, more important even than costs. Anything which would increase production was readily accepted, and fluorescent lighting quickly became the general practice for lighting in industry. The Cooper-Hewitt mercury sources were almost entirely replaced and many filament installations were changed over to fluorescent.

The earlier fluorescent systems employed RF type fluorescent lamps which were in turn replaced by F type lamps (introduced 1942) during the later years of the war. Shadows were softened by the larger area light source, and often the higher levels of illumination were obtained without rewiring. General illumination of 40 footcandles became common in high production factories. These higher levels made it possible to install fixtures in continuous rows without sacrificing good uniformity of illumination, thus effecting a saving in number of outlets and hangers required. War restrictions on materials resulted in lighter weight luminaires and the use of alternate materials for reflectors, many of which were replaced after the war as materials became more readily available.

The advancement of lighting over the years in a small shop is shown in a series of three photographs. (See photos on page 53.) Single lamps on drop cords placed near critical areas, more light added for general illumination, and finally conversion to fluorescent luminaires, are shown.

Although local lighting on the machines dropped off with the increase in general illumination, there was a renewed interest in inspection techniques. Specialized lighting was put to use for inspecting gun barrels and parachute seams and for other similar applications where the general lighting system alone did not furnish the proper quantity or quality of light desired. In welding operations, for example, 1000 footcandles was recommended.

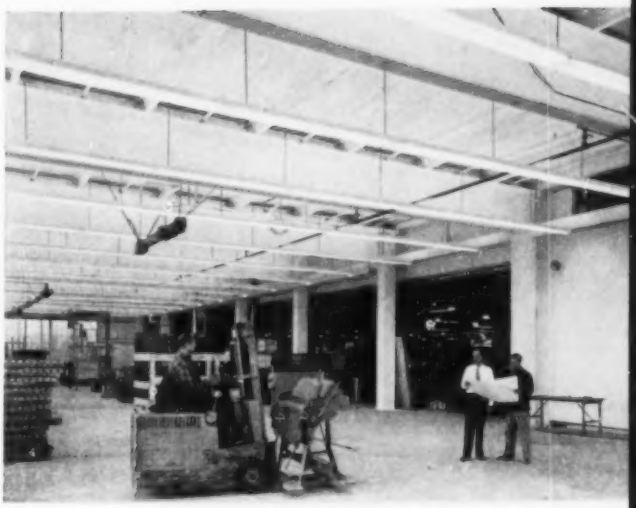
Fluorescent lighting with its wide flux distribution also made strides in the high mounting areas, such as large aircraft plants, since it provided good illumination on vertical surfaces with little sacrifice in utilization. One such installation included double rows at 60-foot mounting height in an area 300 ft by 300 ft. Rows adjacent to the walls were continuous to provide better uniformity of illumination over the entire area. The adoption of the 480/277 three-phase system of power distribution was found to be advantageous and sometimes necessary with the war restrictions on copper wire. The four-lamp sequence start circuit was widely used for these installations. In dirigible hangars (160-foot mounting heights) and foundries the 3000-watt tubular mercury source found wide application.

The need for a well maintained lighting system won recognition during the war years. Methods and equipment for cleaning lamps and fixtures were developed. With the longer lamp life and greater numbers of lamps in fluorescent installations, the idea of group re-lamping got a foothold. It continued to grow as lamp life got longer and illumination levels became higher.

Near the end of the war more thought was being given to improving the visual environment of the worker. Suggestions were made for improving the shielding of fluorescent fixtures; and in machine shops the need for lighter wall, ceiling, and machine finishes was realized. In 1945 the first grid system of lighting was installed to provide good lighting of machined cylindrical surfaces at all orientations.

The years following the war show new developments in light sources which simplified the maintenance problem. In 1948 slimline lamps were introduced, including lamps in 8-foot lengths. The elimination of starters and the reduction in the number of lamps required (longer length per lamp) reduced maintenance costs. The reflector type lamp for general lighting (1950) and the reflector mercury lamp (1952) were developed primarily for use in dirty atmospheres, such as foundries, where maintenance of an exposed reflector surface would be costly. These lamps gained wide popularity in many other industrial areas, and were often used as replacements for the general service filament and mercury lamps while retaining the same external reflector for protection of the glass bulb, and for additional shielding in the case of reflector mercury lamps.

With the availability of higher output sources, and the realization that larger quantities of illumination were desirable, the problem of providing a comfortable seeing environment for industrial workers became very important. The "Revolution in Industrial Lighting" was an application, as far as practicable, in industry of all the known techniques and ideas of providing better quality lighting. These include reducing brightness contrasts in the general surround as well as in the immediate work area.



This photograph points up the Revolution in Industrial Lighting of the early 1950's. The dark area in the background has the "old" type lighting. The relighted area in the foreground uses fixtures with a substantial component of upward light. Ceiling and walls are light in color. Although illumination levels are relatively similar (50 ft-c in old area, 70 ft-c in relighted space), note the vast difference in seeing environment.

Room surfaces were finished in lighter colors. Ceilings, including all surfaces above the fixtures, were painted white, and floors were lightened wherever possible. Machine finishes and immediate backgrounds of work tasks were also lightened. Lighting fixtures were provided with better shielding to reduce direct glare, and with large open slots in the top to allow 10-25 per cent of their light upward to brighten ceiling surfaces, thus reducing brightness contrasts. These improved lighting conditions not only raised the morale of the worker, it was felt, but were responsible for increased production, better product quality, better housekeeping, and decreased accident rate.

With good control of the quality of lighting in industry, desired quantities of illumination are no longer restricted in this respect. The average general lighting level being installed in machine shops today is about 50 footcandles. "Pace-setter" systems up to 200 footcandles have been installed. In view of the better general lighting, there has been

One of the more recent "tools" for industrial lighting, especially in very dirty areas, is the 750-watt R52 reflector lamp. They are used here on 15-foot centers, mounted 30 feet high. Illumination level is 35 ft-c.

less need for local or supplementary lighting except for specialized applications.

In color work the deluxe cool white fluorescent lamp has found wide application in industry since it has a more uniform spectral output. Mercury lamps also have been improved, with the addition of phosphors to the lamp, to give better color rendition.

As of 1956, fluorescent lighting is finding wider application in all fields of industrial lighting. And because of their more favorable cost, fluorescent lamps are now being used at higher mounting heights.

What general practice will be 50 years hence would make interesting speculation. That there will be further changes one may be sure. Any number of factors could change the picture — further advances in light sources and equipment; new concepts in factory design; air-conditioning and acoustical developments; even changes in the working day, and type and/or sex of the average worker. Thought and study will, of course, continue.

Another modern illuminant for heavy industry is the H400-RC1, color improved mercury lamp. In this steel plant, workers under the 30 foot-candles of color-corrected mercury lighting can identify various grades and sizes of steel by the use of colored marks on the ends of the stock.

In current practice, fluorescent lamps, too, are used for heavy industry areas, at high mounting. In this plant fluorescent units are on 22-foot mounting height. Illumination level is 30 foot-candles.

INSPECTION LIGHTING

Numerous specialized techniques have been developed for supplementary and inspection lighting in industry. These photos show only a few.

Directional lighting has been used for detecting surface flaws in etched zinc sheets in a lithography shop. 150-watt reflector spots on 6-inch centers direct light at a grazing angle along surface; imperfections show up as shadows or light streaks.

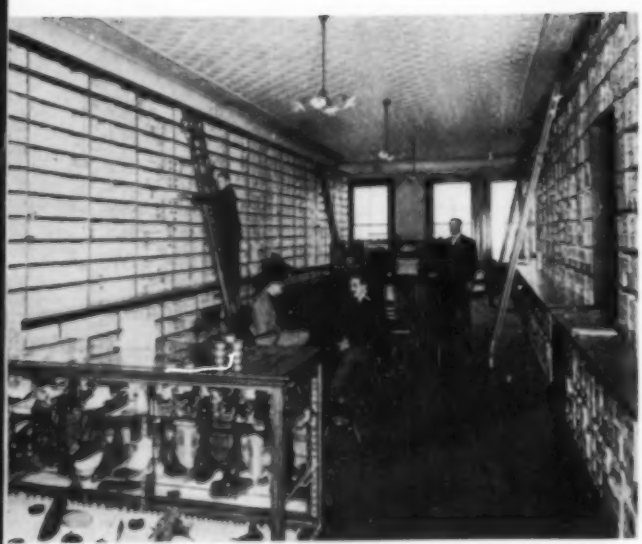
Polarized light for inspecting for stresses and strains in glass bulbs. Polarizing screens are located in the eye piece and directly in front of the light source. Inset shows that internal strains in the glass appear as shadowy streaks.

An application of controlled reflections. Lamp images from banks of fluorescent lamps on each side of a finished automobile are reflected in gentle curves from the highly polished automobile contour. The inspector looks for dings or dents in the metal, which are indicated by distortions in the reflected images of the lamps.

Diffused light for inspection of chrome plate pieces is furnished from two adjacent fixtures, their open bottoms covered with tracing vellum. Each unit contains two 90-watt fluorescent lamps. Inset shows close-up of some plated pieces, in which the flaws appear as dark spots or smears.

Store Lighting ✲ 1906-1956

The photos on these two pages are of the same store at three different times. The store and its lighting were remodelled more often than this, but unfortunately, the other pictures are not available.



1906 — Most small stores of this period were little more than store rooms and the owner depended largely upon his personal charm for attracting customers and promoting sales. Lighting was strictly utilitarian — primarily to enable him and his customers to see the merchandise. As in this store, 3 to 5 footcandles was the usual practice. Whenever a critical seeing task was involved they had to depend upon natural daylight. Display lighting was practically non-existent.

In one of the very early IE articles on store lighting it was said that "the quantity of illumination is ample, perhaps in some cases excessive." The installation being discussed provided 4 to 10 footcandles. It would be easy to sit where we are at the beginning of the 100-footcandle era and look down at the lower levels of the past. But this would be idle because at any stage in the history of lighting, engineers have endeavored to reach a justifiable compromise between the cost of light and the benefits that may accrue, and obtain the maximum effectiveness of a given investment in terms of the tools they had at hand. Let's turn around and look at the heights ahead of us. How can we make the same progress—a tenfold increase — in the next 50 years? We know 1000 footcandles is desirable for medium reflectance merchandise, and much higher levels for dark goods.

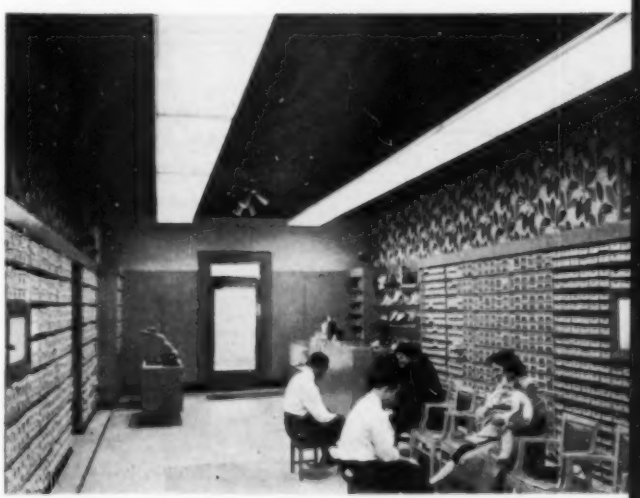
We may feel contented that we know how to analyze the many factors in the complex subject of store lighting. But the first articles on store lighting considered such things as color rendition, luminaire distribution to produce uniformity, reduction of glare, types of display lighting for specific merchandise, footcandles on vertical planes, the attention value of show windows, and the esthetics of lighting. Are we really applying new principles and new ideas today, or are we primarily refining techniques and expanding our fund of data on the kinds of things that have been done before?

We all believe in the future of lighting. Our challenge is to make as much progress as fast as the men who have developed the art and science of store lighting to the point where it is today.

1920 — The age of the enclosing globe. This was also a period of great controversy over desirable surface brightness. Merchants believed that brighter fixtures made the store look brighter; illuminating engineers knew that as lighting levels increased, glare had to be reduced for good results. Gradually the indirect component was increased by making the top of the globe higher in transmission than the bottom. More displays are being used here but still no lighting for them. In department stores and some shops, showcases were often lighted and in a few instances reflectors were used for spotlighting.

1956 — Better looking stores, better display and better lighting (right) are essential for successful store operation today. Pages 61 to 72 outline modern concepts and approaches to lighting. The decade from 1936 to 1946 deserves particular emphasis in a historical discussion. Fluorescent lamps were introduced which tripled light source efficiency. Because of lower source brightness the trend was to use the lamps exposed, a trend which only now is being reversed. Reflectorized lamps were introduced, greatly expanding spotlighting of displays in interiors and show windows.

But perhaps most important was the establishment of lighting as a sales tool instead of merely a necessary operating expense. Within a few years, lighting to attract attention to the store and to displays; to give merchandise maximum sales appeal; and to make the store a pleasant place to shop with an atmosphere fitted to the establishment, became phrases used by both the users and sellers of lighting. The concept formed the basis for a sound method of lighting design, and it proved an important factor in selling better lighting.



Some Outstanding Installations of Their Time

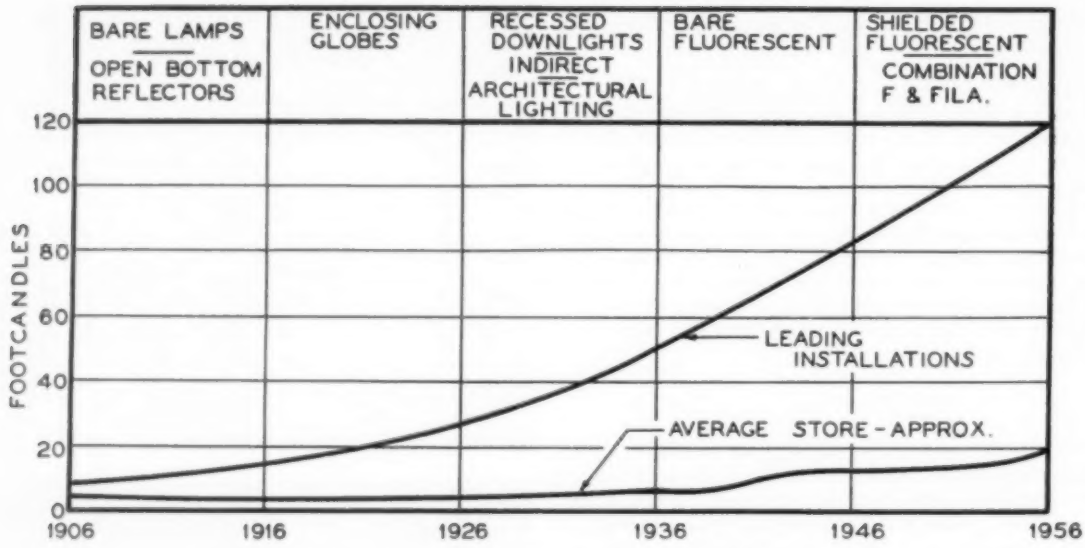
1911 — Gimbels in New York installed 150-watt lamps in enclosing globes. Ten footcandles on the first floor. Other floors ranged from 2 to 5 footcandles. While the levels are far below those we would use today, the illuminating engineering that went into the design was far ahead of its time. Color rendition, glare, maintenance, showcases, horizontal footcandles and vertical footcandles were all thoroughly investigated.

1924 — The Superior-Lakeview Market in Cleveland installed 12 footcandles using 500-watt direct-indirect open bottom units. The store was a forerunner of our modern supermarkets although self-service had not yet become widely accepted.

1932 — The era of "architectural lighting." Bullocks-Wilshire in Los Angeles was an outstanding example. No fixtures as such were used — all the lighting was from luminous panels or other elements which were completely integrated with the architectural design of the interior. Display lighting was good — even for present times. Most cases were lighted, some with tubular lamps, some with luminous tops or sides. About the same time, T. Eaton in Toronto installed 10 to 15 footcandles with a highly developed system of built-in lighting with recognized good appearance, traffic flow, and architectural effects.

1936 — One of the most famous installations was S. H. Kress in New York. Sixty-five footcandles general illumination with 100 footcandles on important counters was provided by an all-incandescent system. Recessed downlights plus special suspended luminaires providing indirect and direct lighting formed this part of the system. Show cases and wall cases were also lighted. Tiffany's also put in a famous installation with indirect lighting on a beautiful coffered ceiling plus pinhole downlights framed to counters below.

1954 — Today, of course, there are many installations to talk about. One, however, that is certainly outstanding is Bettendorf's Supermarket in St. Louis. Downlights using 750-watt R-52 lamps provide 110 footcandles in the high-ceiling central area. In addition decorative units enhance perimeter areas, and a fluorescent cove is used at the change in ceiling height. Case lighting, wall lighting and spotlighting in various areas complete the job.



Trends in levels of general illumination and types of luminaires. The average general lighting has increased about five times in fifty years, and in outstanding installations it has nearly doubled in every decade.

Show Window Lighting

This has been an even more interesting phase of store lighting than the interior. In the early days of the Society there was much discussion of concealment of sources and 10 to 40 footcandles was considered adequate. But in 1922 to 1925 the requirements for making windows effective during the day were established. Two hundred footcandles general illumination and 1000 footcandles on features must have seemed tremendous then. Well-engineered show window reflectors were developed for various proportions of windows and are still among the most popular and effective equipments for the service. In 1924, Sterling and Welch installed 500-watt reflectors on 18-inch centers producing 200 footcandles. By 1932 a survey of stores having window displays showed there were more watts installed in windows than in the interiors! Philadelphia Electric installed a 4000-footcandle window. Merchants recognized the cumulative value of window lighting in attracting more shoppers to their area. In 1936 stage lighting techniques were introduced that expanded the use of color and composition in light.

Then during World War II military restrictions brought to a halt a period of twenty-five years of continuous development and rapidly expanding use of show window lighting. In addition, the introduction of fluorescent lamps led to their use in windows — often to the exclusion of incandescent sources. In these cases of course, daytime effectiveness and dramatic effects were lost.

In the past few years, interest has been renewed. The introduction of higher candlepower PAR lamps has expanded the range of lighting tools.

Now, however, we have an additional problem and opportunity. Open-front stores should and can be made effective during the day. The brightness requirements are the same as for windows, but the solution takes quite a different form and different techniques apply. In the next decade we all expect advances in quantity and quality of general illumination. In stores we should see great strides in the development and use of display lighting — not only to emphasize the merchandise, but to enable open front stores to become the giant show windows they are intended to be.

TODAY'S concepts in the design of store lighting

Today's approach to store lighting makes the illuminating engineer an important member of a team which includes the architect, the interior designer, the display director, the merchandising manager, and the contractor. The necessity for close team work among these men is indicated by the many factors which influence the final design for a given store. In order to act as a more effective member of the team, it is becoming more and more evident that the illuminating engineer must have a better understanding of the other fields. In fact, in the case of a small store he may have to perform one or more of the other functions. It is also true that the more others know about lighting the better position they are in to appreciate the benefits which accrue.

In analyzing the many new installations throughout the country, it is clear that the outstanding ones are the result of the above kind of teamwork. Lighting in the overhead zone is needed to provide the basic sales illumination. Footcandle levels being found advantageous today are in the range of 50 to 100 for most stores and from 70 to 150 for self-service types. Deluxe fluorescent lamps are currently being used widely in all kinds of stores, for their color rendition of merchandise, room finishes and customers. Most popular fluorescent lamp types in terms of new installations are the 96T12 slimline and the 40-watt rapid start types.

With more and more of the ceiling space being devoted to lighting (in some cases the entire ceiling area) particular attention needs to be placed on minimizing brightness and contrast in order to avoid distraction from the merchandise. At the same time, it is desirable to have a stimulating atmosphere and enough pattern to avoid monotonous effects.

DISPLAY AND SELLING AREA →

Factors of Influence

Type of Store

- Kind of Merchandise
- Methods of Merchandising
- Clientele

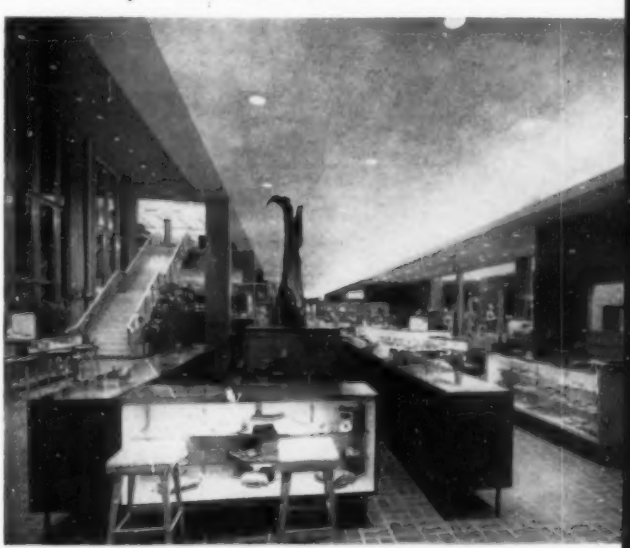
Architectural Character

- Size and Proportions
- Store Layout
- Structural and Mechanical Features
- Surface Characteristics
- Type of Front

Other Factors

- Competition
- Location

↓ OVERHEAD ZONE



Of equal importance to the lighting in the overhead zone is that in the display and selling zone. It is here that maximum attention and interest are desirable. Lighting in this zone affords the opportunity to emphasize any given area or item. In this way the flow of traffic can be improved, high profit items can be emphasized, related sales can be suggested and other types of impulse buying can be stimulated.

Lighting in the display and selling zone is important for additional reasons:

(a) A pattern of brightness results which makes the store a more interesting place in which to shop.

(b) A greater feeling of spaciousness is contributed.

(c) In open-front stores interior displays take the place of those in conventional show windows. Thus for effective display from outside the store, at least some of the merchandise in the interior needs to be lighted to the same level as though it were on display in the window.

Of particular interest in large stores is the development of vistas which invite the customer to go from one area to another or to go from one floor to another. Brightly lighted feature displays or special ceiling treatments play a key role in the effectiveness in this kind of planning.

In the majority of stores, merchandise is more or less uniformly distributed on the floor area and a uniform level of illumination is desired. Because of the low overall cost of light and association with being modern, fluorescent sources are usually chosen. However, in any store a directional component is needed and can best be supplied by incandescent sources. Where sparkle, highlights and shadows, emphasis on texture, are needed through the whole floor area, the incandescent component would also be designed to provide a uniform footcandle level.

In most stores, the area between the tops of the cases and the ceiling is an important part of the field of view, and its treatment lighting-wise has a major effect upon overall store appearance. Colored lighting in this area is increasing in attention because it is an easy way to get distinctive effects, to differentiate between departments, and to create a cool or warm atmosphere, depending upon the season.

For dramatic effects with plenty of sparkle,

highlights and shadows, incandescent general illumination is often chosen even though operating costs may be higher. Because the sources are small, a small fraction of the ceiling area is covered with lighting fixtures and, if brightness is properly controlled, lighting can be inconspicuous. Random arrangements are useful as a change of pace from the usual geometric layout.

Chandeliers of contemporary design are often used to characterize the space and so are moving or stationary abstract designs.

It is difficult to convey in photographs the stimulating feeling and pleasant surroundings that result from well-designed lighting in the display and selling zone. There is no doubt of its value, however, when one has an opportunity to experience the results in an actual space.

In a great many stores the sales and circulation areas are sufficiently separated so that the lighting can be varied from one to another. Footcandle levels for circulation areas may be one half or less than in sales areas. Illumination for feature displays should again be doubled or more. Thus, today's recommendations suggest that if 50 footcandles are used in the selling area, 100 footcandles are needed for displays, and 200 or more for feature displays.

As footcandle levels are increased, the need for reduced fixture brightness at normal viewing angles is increased. Shielding the lamps from crosswise view is a logical first step because the brightness of the tube is greatest in that viewing position. Still greater improvement in appearance and reduced distraction from the merchandise result when the lamps are shielded in both directions. Light colored ceilings are desirable to reduce contrast between the fixture and its surroundings and thereby make it less noticeable.

In contrast to the technique of applying lighting fixtures to a ceiling, is the integration of lighting with the ceiling design. This may take the form of recesses in which lamps are placed to provide partial shielding, or of placing lamps on the structural ceiling with diffusing media of louvers, plastic or glass to form a visual ceiling below. In any overall ceiling treatment, attention to change of pace or variation is desirable to obtain an interesting environment.

The subject of store lighting includes restaurants and service establishments — in fact any place where goods or services are sold. While the functional use of light may vary widely from one to the other, the environmental aspects remain largely the same. Actually in any space lighting is as fundamental a consideration as space, mass, form, finish, line and color.

In large stores and small . . . lighting to EMPHASIZE THE MERCHANDISE

- Focuses attention on display and selling area
- Makes a more pleasant interior
- Creates greater feeling of space
- Promotes circulation throughout store

Relatively long narrow spaces can be made to look shorter by varying the floor, wall, and ceiling treatment by breaking the rows of fluorescent fixtures and by highlighting unusual displays to form a series of focal points.

If one were to survey existing store installations, it would not be surprising to find that far more attention has been paid to lighting in the overhead zone than to lighting designed specifically to emphasize the merchandise. On the other hand, such a survey could be expected to show perhaps one per cent in which adequate spotlighting, case lighting, or the many other techniques available have been installed. Based on past experience, one would find the owners of these installations enthusiastic about the sales volume such lighting produces. A survey of new lighting installations would probably show a disappointingly small proportion in which lighting is used effectively in the display and lighting zone. It follows that one of the important needs in the future is to advise the buyers of lighting and to train the sellers of lighting in this phase of store lighting design. To the buyers it has equal benefits to those obtained from the general lighting system, and to the sellers the two are about equal in potential.

While the spotlights are located in the overhead zone, for purposes of this discussion, they are included in lighting to emphasize the merchandise. This part of the lighting makes the overall effect more like the sunshiny day as contrasted with a cloudy one.

Lighting in wall cases and show cases makes them effective displays rather than merely storage areas.

Spotlighting for counters below and continuous valance treatment are essential ingredients of this successful installation.

Two rows of fluorescent lamps are needed in most perimeter installations where adequate general illumination has been provided. One row of lamps is used to light the upper wall area and another to light merchandise on display in the cases. Some installations have three rows.

Fluorescent lamps contribute line highlights to emphasize the form of polished or shiny surfaces. The reflection of incandescent filaments creates point highlights to create sparkle and bring out sheen in shiny materials. Overall brightness is usually a function of illumination being diffusely reflected from surfaces, although sometimes it is possible to surround shiny objects with luminous areas to obtain it by reflection.

In some installations, practically all of the lighting is designed to emphasize the merchandise. This is in keeping with the trend toward using the merchandise itself for decoration and subordinating everything else in the store to it. Note particularly how the spotlights are made inconspicuous by painting the outside of the housing the same as the ceiling, and how the downlights at the rear are hardly noticeable. Note also how effective is the use of light finishes on the ceiling, walls, floors, fronts of cases, and insides of cases, with just enough dark areas for effective contrast.

The merchandise itself is the star performer here, providing both decoration and effective display. This is accomplished by subduing the overhead lighting with fixtures with the sides painted the same color as the ceiling, emphasizing the perimeter with wall lighting from above, and highlighting the displays with individual lamps in each niche.

General illumination here is entirely incandescent and is confined to the immediate sales area. This puts particular importance on lighting for the perimeter areas and for displays, since otherwise these would be dark. Fluorescent sources behind a translucent drapery provide an effective setting for spot-lighted manikins.

In addition to the conventional valance treatment, fluorescent lamps are used vertically at the sides of this wall case for additional emphasis. Small diameter tubes and small cross-section reflectors minimize obstruction of the view of the merchandise. Spotlighting from above adds sparkle to plastic wrappings and helps bring out the warm colors of the goods.

Tests indicate that on fresh meats, satisfactory emphasis without unsatisfactory heating effects can be accomplished with downlighting in the range from 30 to 50 footcandles with incandescent sources, in addition to the light provided by the fluorescent overhead system.

High-intensity spotlights
Fresnel-lens spotlights. Adjustable for general lighting or accent lighting
200-watt par-46 spot lamps
150-watt par-38 strips for background lighting

One method of display window lighting.

Attracting

Ever since the first work by Harrison and Sturrock it has been known that it is feasible and practical to provide enough brightness in show windows to make them effective during the daytime. The principle involved is merely that of making the display as bright as the reflection in the window. It was found that overall illumination of about 200 footcandles, with accent lighting to provide about 1000 footcandles, would provide satisfactory results.

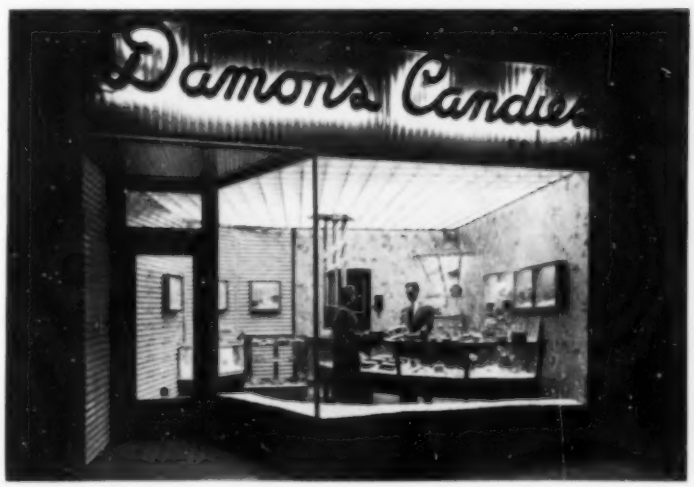
With the advent of the open-front store, the problem was again encountered but in a somewhat different form. While the objective of the open front is to make the store a giant show case as seen from the street; in nearly every instance this objective was defeated in the daytime because of reflections that prevented seeing into the store. The solution is the same as for show windows — it is merely a matter of providing the above levels of illumination in key areas within the store. This can be accomplished by several techniques.

The photo, below left, was taken with no lighting on in the window on a bright cloudy day. Reflections in the glass obscure the display. In the photo, below right, all lighting has been turned on. General illumination with fluorescent and incandescent lamps is about 200 footcandles. Accent lighting is of two forms: Emphasis on manikins is provided by 200-watt PAR 46 spotlamps and additional emphasis on gloves and fashion cards by automobile spotlamps operated on transformers. The background lighting is from special strips toward the rear of the window in color — red, green and blue on separate circuits for flexibility in setting the mood of the display. The range of brightness in the window cannot be conveyed in the photograph, but it is evident that the reflections are barely noticeable. See I.E.S. Lighting Data Sheet 12-97, December 1955 I.E.

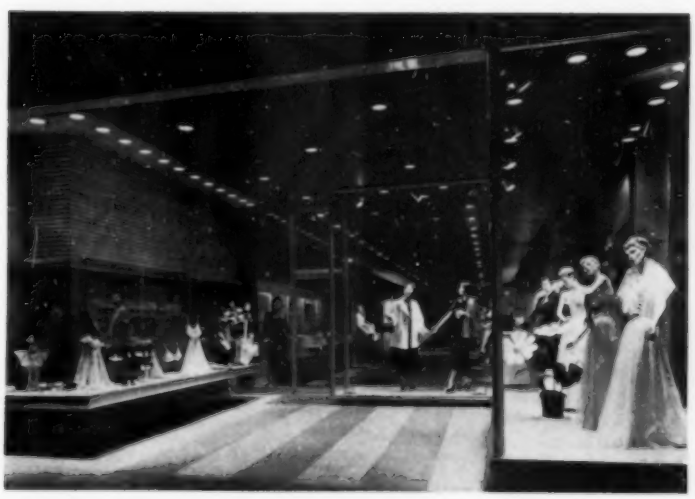
Passing Shoppers

Part of the ever-changing pattern of merchandising is the trend toward more and more night shopping. While the reflection problem is not as severe, about the same levels as used during the daytime are desirable to meet the competition of other stores and other attractions which are competing for the customer's dollar. When the store is open of course all the lighting would be turned on. After the store has closed, leaving the lighting on in the display and selling zone has been found to be exceptionally low-cost advertising.

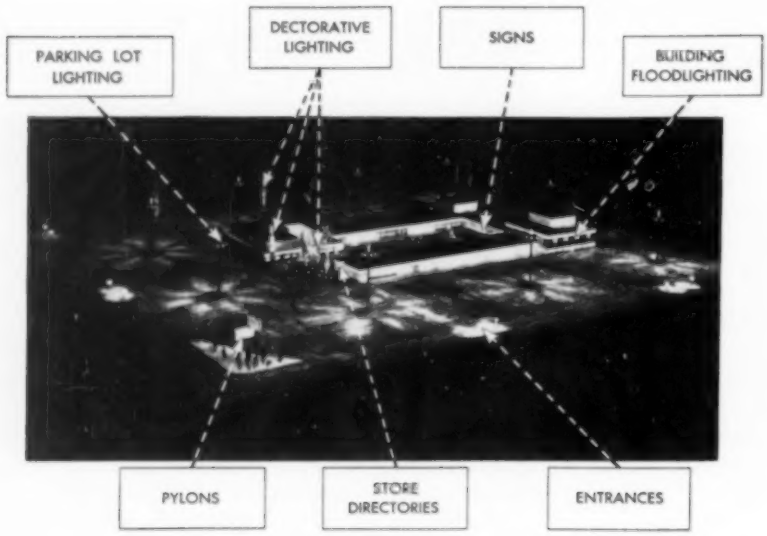
There can be no doubt on the part of the prospective customer that this establishment is open for business and its pleasant cheerful appearance implies the same kind of service. The luminous wall is lighted with fluorescent luminaires on the ceiling which also light the work area.



As a result of lighting in the display and selling zones, this shop is effective from the street both day and night. A spotlight under the canopy lights the corner display while fluorescent lamps provide high brightness in the wall niches and floor cases. The interior sign on the column stands out as a result of a spotlight directly above. In addition to its great importance in attracting attention from the street, lighting in the display and selling zone compels attention and adds interest when one is inside.



Spotlights and some fluorescent case lighting left on for nighttime display is a kind of low-cost advertising which has the advantage of creating impressions first hand, in three dimensions, and in color. When the store is open these advertising impressions are created at a time when customers are in a position to act immediately on impulse.

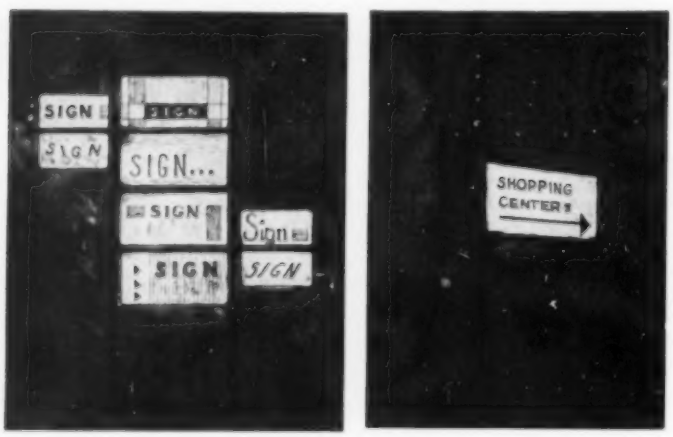


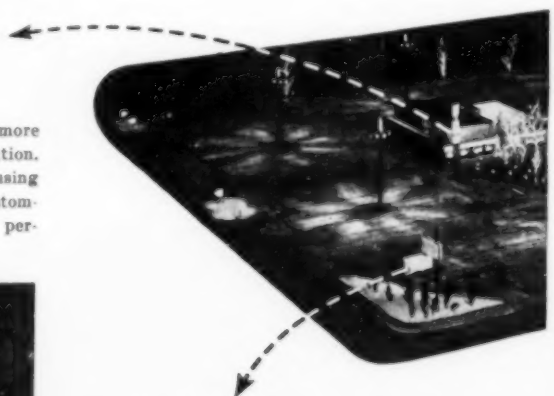
Shopping Centers

Perhaps the most important movement in merchandising during recent years has been the suburban shopping center. Early centers were usually relatively simple strips of stores in which the supermarket often formed the nucleus. Today the emphasis is on large regional shopping centers designed to meet practically all shopping needs. A large proportion of new construction has been in shopping centers and today some cities are finding that there are more stores than justified by the population. This has caused numerous failures in shopping center ventures and has led to keen competition between existing centers. With the increase in night shopping, lighting is assuming increasing importance in serving the varied requirements as outlined here.

To meet the competition of shopping centers, older downtown areas are finding it necessary to provide better facilities and greater attraction. Lighting-wise, many of the considerations in shopping centers also apply to such areas.

Store Directories — Regional shopping centers may have 100 or more stores so that guiding customers becomes an important consideration. Directories may take many forms; shown here is one suggestion using standard production enclosed plastic signs to give a distinctive custom-built effect. Lighted internally with slimline lamps, these give good performance and adequate legibility down to zero degrees F.





Pylons — Where a shopping center is located next to a high-speed highway, it is necessary to provide identification at a sufficient distance to enable people to decide to stop and reduce speed before they reach the entrance. Assuming an internally lighted sign, letter height should be one foot for every 600 feet legibility distance. Exposed lamp type signs also apply. The 11-watt S14 enamelled sign lamp and the 20-watt flashing sign lamp are popular types.

Parking Lots — The trend in parking lots has been to provide about one footcandle, although today there are several lots being lighted to two footcandles, and a few at five. The safety, convenience and sense of well-being are important factors in attracting customers and encouraging them to return.

As to technique, one popular system has been to use conventional street lighting equipment. As to type of light source, incandescent lamps provide good control of light and excellent appearance of colors of people and automobiles. Because of their long life and high efficiency, mercury lamps have been widely used. Although color-improved types seem to be preferred to straight mercury, color effects are not as widely preferred as with incandescent. Fluorescent street lighting equipment is becoming more popular, again because of long life and efficiency, and because glare and distraction are reduced over smaller, brighter units.

All the above systems provide for easy maintenance from a ladder truck, since mounting heights are in the range of from 25 to 40 feet. On the other hand, from the appearance standpoint, several objections have been raised. First, a relatively large number of poles is required. Second the units are down close to one's line of sight where they distract considerable attention from show windows and signs. Third considerable trenching is required for wiring, and the possibility of damage to poles or automobiles increases with the number of poles.

The above considerations have led to a great deal of interest in using tall poles (80 to 100 feet) equipped with a suitable number of high-wattage floodlights using incandescent or sometimes mercury sources. This has several advantages:

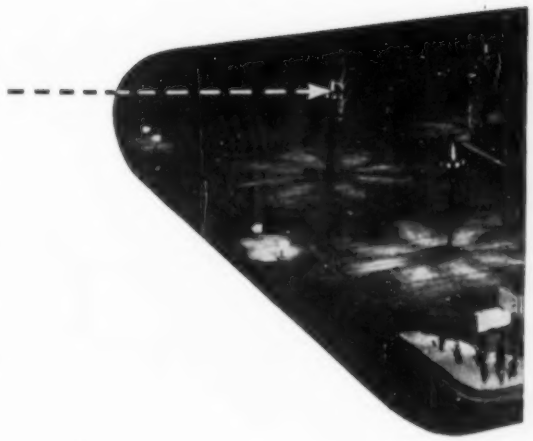
(a) Lighting units are well above one's line of sight where they do not detract from signs and show windows.

(b) Few poles are required so that the appearance of the lot is less cluttered.

(c) The top of the pole is a suitable place for attraction devices and because of their high mounting these can be seen at great distances from the center.

(d) Less trenching is required because wiring has to be taken to only a few locations.

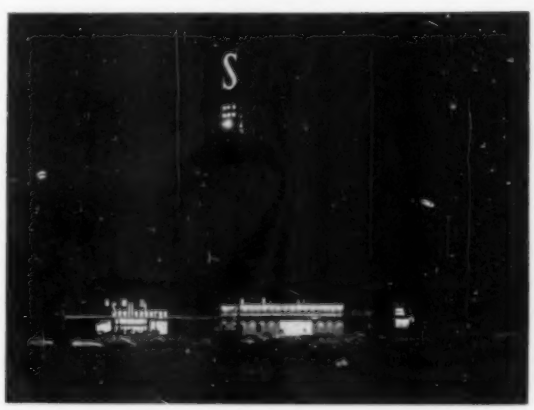
Maintenance is somewhat higher than for the other systems. However, this can be minimized by a group relamping plan. Based on about 600 burning hours per year, lamps can be replaced annually and fixtures cleaned at the same time.

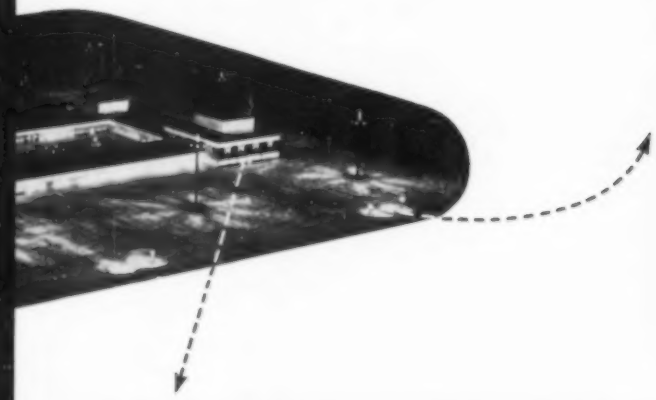


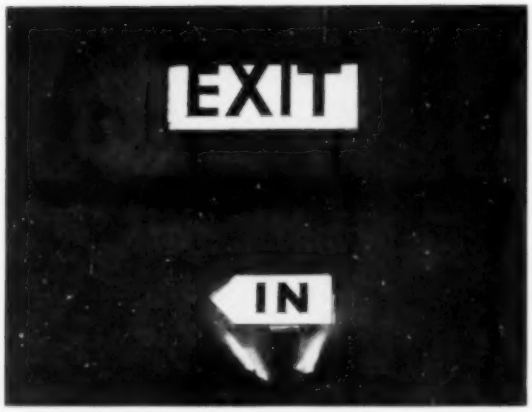
Filament

Mercury

Floodlighting







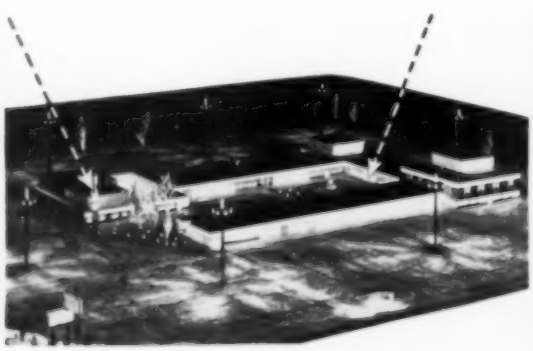
Entrances — Additional lighting here is desirable — particularly when there is a rapid flow of cars in and out during rush periods. Low mounted units combine a sign to identify the entrance and additional light on the pavement.

Building Floodlighting — A great deal of attention is paid to the size and proportion of buildings, building materials, textures, colors, etc., in terms of daytime appearance. Equal opportunities exist at night when architectural features and characteristics of materials can be emphasized even better than in the daytime, and color can be introduced for additional attraction value. Almost any of the building floodlighting techniques apply. Of particular interest is the recent development of high-output fluorescent lamps which not only have higher output per foot than regular types, but maintain their high output at low temperatures.

Signs — One objective is to maintain some standardization of type and location to provide unity throughout the center. Of particular interest is the facia sign because a continuous band of light helps to tie the center together and increases its attraction power.

Decorative Lighting — Leading architects today are thinking in terms of beautifying the center so that a shopping trip is the big event of the week for the housewife. Lighting of trees, plantings, and flowerbeds; lighting of sculpture and decorative features; walkway and fountain lighting; provision of Christmas decorations and other seasonal or promotional activities are some of the considerations. Decorative pylons, as shown here, are another possibility for adding interest and contributing to overall attraction power of the center.

Signs



Decorative

Quest for Quality in Office Lighting

"Quest" is aptly descriptive of the office lighting field. Throughout the life of this Society, those interested in office lighting have from the beginning sought out the principles of seeing, have engineered improved equipment, have established more comprehensive recommendations. As the history of these accomplishments is read or recalled, there comes the realization of how early the objectives were defined — of how tremendously their interpretation has been enlarged. For the future — there is still much left.

In the instance of office lighting, the historical trends and progress are quite naturally measured against the new Recommended Practice of Office Lighting (1956). This Practice represents the Society's current summary of knowledge, practice and recommendations. It provides a comparative measure for the past.

Altogether this new Practice was under study by the Committee on Office Lighting for eight years. Much of the final compilation, however, was done within the past year, concurrently with the research for this review. There were striking similarities between the interpretations of objectives, the definitions of problems, yes, even between the personal opinions and contentions that were presented to the current Committee and those that are to be found in the earliest literature of the Society.

Echoing down through the years, and a paraphrase of many a recent comment in committee deliberations, are these remarks of the Society's first president, L. B. Marks:

". . . There is perhaps no question that is in need of more immediate attention than . . . that unshaded or inadequately shaded lamps are the

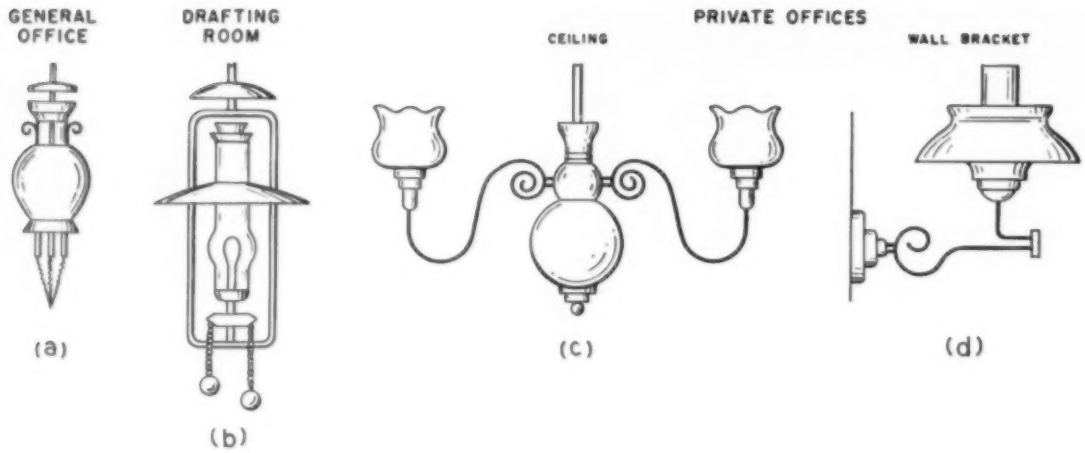


Figure 1. Equipment used in Consolidated Gas Company offices, Baltimore.

rule rather than the exception. . . . The practice of placing lights of excessive brightness within the ordinary field of vision is so common as to cause great apprehension . . . (and) . . . Much of the trouble due to this cause would be removed if the light sources were concealed and the illuminating power from them was derived from reflected rather than from direct rays."

That was expressed in 1906! The principles of good lighting practice as we know them today were expounded by a few of lighting's forefathers, though they must have felt sorely limited by the means available to them.

To orient the contemporary reader as well as those who may peruse these notes in the years to come, a review of the sources and equipments in common or advanced practice when the Society was founded seems in order. Gas was in widespread use. Kerosene lamps were not uncommon and were held by some vociferous proponents to be the only "artificial" sources without harmful rays. Electric arcs were being used in increasing numbers outdoors and were being applied in a limited way indoors. Mercury and other gaseous discharge sources had been introduced. Incandescent lamps had been in use for over a quarter of a century. They were undergoing marked improvements in efficiency and durability by 1906, and were being produced in larger and larger sizes.

As with many a new invention, however, the methods of application of the wonderful new source were as often as not related to its predecessor. Even as the new automobile came equipped with a socket for the buggy whip, so the new incandescent lamp was used upright like a candle or other flame source, and even had a "candle-cup" under it.

But the quest for quality had already begun — perhaps from dire necessity, considering the circumstances of close office work and the prevailing conditions. Probably the first solution was from the office worker himself. His eye-shade was standard equipment in 1906 and was even more important than his black sateen sleeve-protectors. Illuminating engineers, however, were early seeking a means to office lighting comfort less primitive than this.

In the area of "quality" suitable for offices, activities (from the vantage point of fifty years later) in 1906 are more accurately described as groping rather than searching. But again we come up with the fact that many of today's concepts were firmly held by the early pioneers. The impression of many of us is that "brightness engineering" is a rather new concept. It may prove disconcerting, but interesting anyway, that these statements were made in the review of an early installation: "Footcandle is absolutely meaningless to the layman, and expresses a vague idea to the average architect and engineer. . . . Illumination (is) received by a surface. The apparent brightness . . . of the surface as seen by the eye depends not only upon the amount of light falling upon the surface, but upon the amount of light which the surface reflects to the eye. . . . Result that we are after is, therefore, the intensity of illumination received, multiplied by the coefficient of reflection of the surface illuminated." So say we all — now!

With regard to quantity recommendations, even these far-seeing men seem to us rather naive. Said they, for office desk use "the intensity should not be less than two footcandles nor more than three." A speaker at one of the first meetings of the Society, in tackling the problem of quantity admitted that

few instances of *interior* measurements had come to his attention. He recommended that the subject be given the same consideration and experimentation that it had received in street and road lighting. He quoted one "authority" that 10 meter-candles should be minimum desk illumination and that 50 meter-candles represented good practice. The levels in the Library of Congress varied from 0.25 to 1.87 candle-feet according to his information. Yes, "candle-feet" is the term recorded. Another reference suggested half-candle-foot for street lighting, and one and a half for offices. Apparently the debate was launched early, which continues up to this day, on how much light is enough or too much.

Illumination levels listed in the 1956 Office Lighting Recommended Practice are no doubt exceeded in many current installations, but just as many, perhaps, are less than recommended. The quest for recommended quantity, let alone optimums, still goes on.

And the quest for quality, not in just isolated instances, but in nearly universal use goes on. The aspects of poor quality on which our early leaders were hammering are still a subject for education. Guidance is still given to mid-century readers, in the new Recommended Practice, on such things as shielding, furniture placement, surface reflectances — and the avoidance of discomfort glare, whether direct or reflected. Nearly fifty years ago Steinmetz went after shadow problems this way: "It is to consider how much directed light and how much diffused light are required." It's worth breaking into his quotation to note his verb "are." He seemed to recognize the fundamental that nearly every lighting installation has *both* direct and reflected or diffused light and that the proper balance was the objective. "A satisfactory illumination is given by many small units or by indirect lighting. . . . An unsatisfactory illumination is obtained from a few units even when properly distributed to give uniform intensity over all, but giving little reflected light." Steinmetz recognized that the reduction of shadows on office tasks may require something more than satisfying a light meter as to the uniformity of illumination delivered.

The 1906 and 1907 *Transactions* are rich with references still apt today. Principles of good lighting were expounded in many an early paper. One wonders what contributed most to the delay in their wider application.

One contributing factor may have been the dearth of instruments for measuring light, and more confusing still, a lack of knowledge of the characteristics of the light sources at their command. Even today, we are not all agreed on how to evaluate comfort and quality, and we have yet to produce an instrument for measuring them. But when I.E.S. was young, our technical committee members were arguing about whether "lights weak in chemical rays are better suited to the eye than others. . . ." It's small wonder that refinements in application awaited the answer to such questions as these! Major advances in office lighting, as in every other phase, were evolved usually when predicated on basic, objective research.

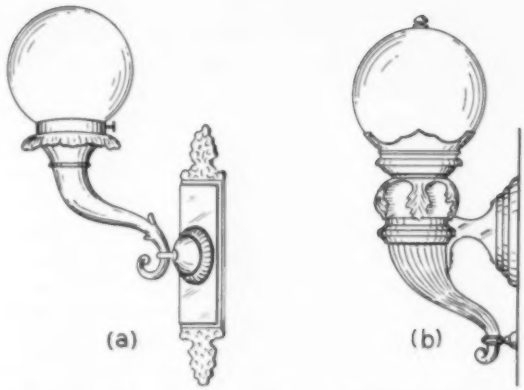


Figure 2. Wall brackets, 1907: (a) "Poorly designed bracket," (b) "Well designed bracket."

Our debt to the founders of I.E.S. can begin to be appreciated when we realize that the knowledge obtained through these researches was duly recorded and disseminated by the Illuminating Engineering Society. First, by a high percentage of the members. Later by fewer and fewer. More recently it has remained for a group of lighting practitioners, salesmen and application engineers to practicalize — yes, even "popularize" advances as they come along. Throughout the years, the studies of I.E.S. Committees, based on what knowledge they had currently available, gave them their lead.

Currently, we do have an array of instruments for measuring the quantity of illumination, but such was not the case in the early nineteen hundreds. Only a few seemed to realize the tremendous levels represented by daylight — and the relative insignificance of the differences in illumination being discussed for indoor office use. The majority were therefore shocked, dismayed, even disbelieving when L. J. Lewison presented his paper "Intensity of Natural Illumination Throughout the Day," at the second convention of the Society in 1908. With the equipment at hand, he had determined that daylight reached the astounding level of 12,000 footcandles. This was bewildering information. One can imagine the consternation.

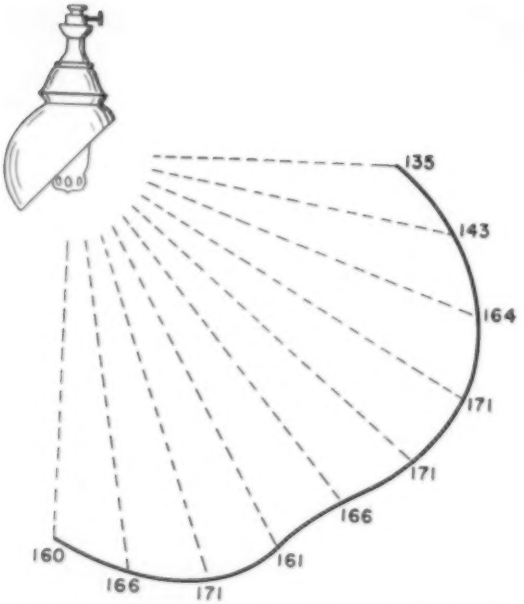


Figure 3. Gas-fired unit for "draughting rooms," with the asymmetric distribution shown.

Proponents of daylight had been decrying the brightness of gas mantles, globes lighted with electric arc and incandescent lamps. Others had vigorously derided the propriety of exceeding one, two, or three footcandles for tasks found in offices.

Not too surprisingly, the record also contains examples of contentions over aesthetic matters, too. Our early leaders were forging concepts on how fixtures should be styled at the same time they were concerned with their lighting performance. A contemporary might wonder at there being any choice, but the illustration in Fig. 2A was frowned upon, while that to the right (Fig. 2B) was praised. The unit to the left was criticized because the arm was "apparently" fastened to the wall plate in a very light manner and gave the impression that it might fall down. The fact that it didn't fall was insufficiently satisfying. The unit to the right had "evident lines of structure" and appealed as having a feeling of "security and restfulness." So said an architect and engineer teamed up in 1907.

These wall units were quite typical of those used in office buildings fifty years ago. But a sympathetic review of descriptions and illustrations of other lighting equipment might well temper any undue pride in thinking all good lighting designs are of recent origin. For instance, the gas-fired unit shown in Fig. 3 was for "draughting rooms." It gave the asymmetric distribution shown, and won the praise of gas and electric men alike, for its fundamental principles. Only on rare occasions in recent years have there been instances of using so refined and specialized a technique for drafting-room lighting — or in other specialized office areas, or procedures, for that matter.

For the most part, however, private offices were equipped with a ceiling "shower" unit, quite ornate, and undoubtedly quite uncomfortable. Bare lamps poked out from the glass "shades" directly at an office occupant no matter where he was located. (There were few female employees in offices, yet.) Desk lighting was supplied by drop cords fitted with cone-shaped shades. Flexibility was provided by a slip-loop in the drop cord, and by a surface wiring raceway that allowed for the cord locations to be moved. The raceway was set out from the wall a distance, placing the drops over a desk. This allowed for desks to be moved "along the walls" and permitted moving the drop lights accordingly.

Development of a light opal glass, lightly ground on the inside of a globe, opened up another phase of the equipment evolution. Performance was so superior to other globes of this type that it and the glass came to be known in the industry as ESB — Engineering Society's Building-glassware (Fig. 4). G. E. Knox had the distinction of preparing a review of the lighting in this Engineering Societies' Building for the I.E.S. His record will be found on page 445 of Volume II (1907) of the I.E.S. Transactions. For the serious student of typical "advanced" lighting practice of the time, and a record of a complete illumination system which had been engineered (rare in 1907), Mr. Knox's detailed description is recommended reading.

Pictures of early office lighting installations are not available, if indeed, the photographic art and lighting available then permitted many indoor shots. Among the actual installations described,

Figure 4. Globe of light opal glass, known as ESB — Engineering Society's Building glassware.

however, was the one in the International Money Order Division of the New York Post Office. Since ". . . a local illumination of from two to four footcandles has been found by extended experience to be required," one proposal recommended a system using 135 drop cords with 16-candlepower lamps and nine 8-light clusters on the ceiling. Instead, however, a few Cooper-Hewitt mercury vapor lamps were installed. After ten months' use, the illumination was measured at 61 luces, or about 6 footcandles. Some two to four footcandles were thought to be enough for the work involved, but the output of the Cooper-Hewitt units was such that some six footcandles were obtained by the time enough fixtures were installed to provide reasonable uniformity.

Another early installation was in the drafting room of the Illinois Steel Company in Chicago. George C. Keech designed and reported this installation. Hoping for 11 footcandles, he found only 9.7 after nine months of use — 13 per cent less than designed. Wiping off the tubes (and reflectors in this case) raised the illumination 12 per cent. This is one of the earliest examples of practical maintenance data to be found.

The public consciousness of color of light was likewise being shaped at this time. Those interested in the application of the long-tube discharge lighting (from the tube developed by D. McFarlen Moore) and mercury-source illumination had much to say on this subject.

A very notable advance in this connection was the experimental installation in the editorial offices of the *New York World* which featured a highly imaginative (for the time) system of 100-watt series type tungsten lamps run in series with the Cooper-Hewitt tube (Fig. 5). Described as the first commercial attempt to alter the color value of the Cooper-Hewitt tube under working conditions, the system was installed for tests conducted by Albert J. Marshall, with the assistance of W. A. D. Evans of Cooper Hewitt and T. W. Rolph of Holophane. The object of the tests: to ascertain the variation and intensity of illumination at various points throughout the space, on a plane approximately equal to a common desk level. In an excellent paper describing this installation, Mr. Marshall not only gave complete details of every phase of the installation, but reported also quite extravagant praise of the lighting result. A Mr. Thurlow of the *World* (newspaper) in commenting on this job felt that "When I went in (the office) after it was installed, I thought it was daylight, and that is what everyone remarks who comes in. We have recently taken on a lot of new reporters, and their first remark is 'What time is this; it must be noon!' . . . Gentlemen with red neckties appear to have red neckties, and gentlemen with blue, will appear to have blue neckties, as though it were sunlight." Mean footcandles were found to be about 4.0.

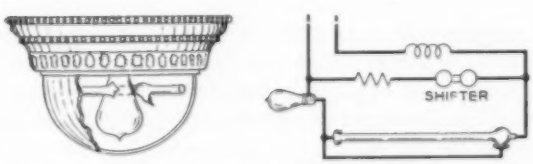


Figure 5. Tungsten lamp, of 100-watt series type, run in series with the Cooper-Hewitt lamp for improvement in color.

Evolution of Techniques

One of the most interesting aspects of a study of the history of a thing, be it a language or a lighting technique, is to recognize the origin of current practice as it emerges from the record. Ideas for fixture design and application methods did not leap into some contemporary mind full blown. They evolved, one from the other, gradually. Increased knowledge of lighting principles and researches on the relation of light and sight, gave them their lead on *what* to aim at. Techniques for getting whatever level of illumination they currently thought was suitable, under the circumstances of whatever limitations they currently faced, forms the history of office lighting practice. The origin of many 1956 office lighting methods can be recognized, if only dimly, in very early fixture designs.

The arc concentric diffuser shown in Fig. 6 was illustrated in a paper published in 1907. It was reported as being a bit lacking in appearance features but excellent in lighting performance . . . "with no placed lights, the illumination for writing or reading is as near perfect as it could be." There's an obvious resemblance between this unit and the many later diffuser-reflector combinations.

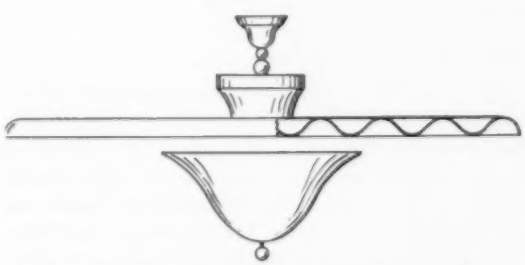


Figure 6. Concentric diffusers with inverted cone alabaster globes.

The principles of even the Parabalum ceiling of the late 1930's are here evident.

Although the best minds in the illumination field in 1906 were advocating that all light should be directed straight to the desk (direct footcandles were more effective than diffuse by 4.5 to 2.7 said one paper) a few early leaders were already designing, developing, and "defending" concealed lighting. Most were with coves. When folks were allowed to select the amount of light they liked in typical tests, they chose 4.5 footcandles with the concealed, 2.7 with direct. The majority of that day concluded that direct footcandles were more effective than diffuse by 4.5 to 2.7.

As early — and there may have been even earlier ones — as early as 1905, an installation of the suspended-type indirect fixture was put into use. Fig. 7.) Its ancestry to units designed years later is quite apparent. This forerunner of indirect luminaires was installed in the Willard Parker Hospital in 1905. There were six fixtures such as this in each ward, the area served being some 56 by 39 feet, with a 13-foot ceiling. Five 16-cp lamps were arranged horizontally in a hemispherical bowl coated inside with white enamel. The outside was brushed brass. A clear glass cover across the top of the bowl cut efficiency 10 per cent, but was used to ease maintenance. Thought was given to the use of a prismatic glass cover to spread the bright circle of light on the ceiling, but apparently it was not employed.

The introduction of indirect lighting met with considerable opposition. In addition to hot discussion at I.E.S. meetings, apparently a bit of editorial controversy broke out between the *Illuminating Engineer* (not to be confused with I.E.S. Transactions) and *Electrical World*. The latter urged adoption of higher levels pointing out that new improved incandescent lamps would be 56-cp sources as compared to the 16-cp of the old 3½-watt carbon filament sources. Its position was that there was "a long way to go in most artificial lighting installations before arriving at footcandle illumination equal to that produced by daylight in rooms well provided with windows." Until that point was reached, this magazine saw no cause for worry as to excessive illumination.

Back came the rebuttal that a stand for higher standards of quality did not of necessity signify the need for raising intensities. "The enormous difference in quality between electric light, or any other of the present forms of artificial light, and diffused daylight, should not be lost sight of. The most important single quality of light . . . is diffusion; and in this respect there is simply no comparison between the best efforts of artificial illumination, even by the so-called 'indirect' method, and the diffusion of daylight."

Figure 7. Indirect unit with hemispherical bowl coated inside with white enamel, outside is of brushed brass.

Today's reader who encounters the voluminous opposition to indirect lighting in these early days is more than a bit perplexed. The following comment, for instance, is pertinent in that it defined an important fundamental of comfort as we know it today, even though it was expressed in opposition to indirect lighting: "Where indirect lighting is used . . . the brightness of the ceiling is going to be greater than the brightness of the thing that is looked at! . . . the bright ceiling kills the brightness of the surface that you really want to have bright . . . the principal illumination should be on the work." Another opinion was that "We have not yet reached a plane of efficiency in artificial illumination where we can afford that class of lighting," and the speaker added, "Even if it had advantages, but it does not."

As one reads the history of these early attempts to apply illuminating engineering to office lighting practice, he becomes aware of the tensions but also the enthusiasm of the Society pioneers. The researcher becomes aware of the errors of the time, but also the perspicacity of the leaders in many of the fundamentals. One is led to reflect that many of the errors still prevail, that in some respects we've made more progress in accumulating opinions rather than sharpening and deepening basic understandings. But of a certainty, there has been auspicious progress, too.

For instance, in 1908, the presentation of Augustus D. Curtis and A. J. Morgan before the Chicago Section, launched the "practical era" of indirect lighting. They noted that previous techniques were expensive, inefficient, usually too much so to be justified.

There were several important details in the technique demonstrated by Curtis and Morgan, but the significance of their proposal lay in the combina-

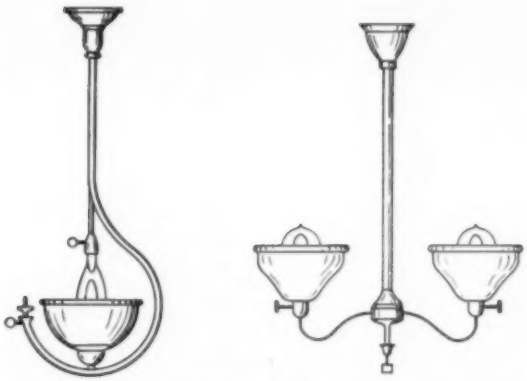


Figure 8. Inverted bell shapes with configurated mirrored-glass reflectors.

tion of the principles to practicalize indirect lighting. The reflectors were designed to concentrate the light "on" the ceiling. The units were hung in the center of the room to further minimize losses due to absorption by the usually dark-finished walls. The reflectors were efficient, durable, permitted easy and thorough cleaning. They recognized, in their summary, that the ability to see details was the criterion for the effectiveness of the illumination, and that a bright, naked lamp in front of the eye hampered this ability, the level of the illumination notwithstanding.

The units demonstrated were inverted bell shapes which contained configurated mirrored-glass reflectors. Circular and vertical corrugations were introduced into the reflector design to "throw rays without shadows" — or to eliminate the striations that the then-clear lamps would tend to produce on the ceiling. The outer surfaces of these blown-glass pieces were coated with pure silver. The completed reflectors were placed in a spun brass casing. The authors took cognizance of gas and electrical applications — and combinations — "When gas is used a satisfactory lamp is the high-grade incandescent-mantle burner. When electricity is employed, the tungsten lamp proved excellent for the source of light."

When the Society launched its custom of presenting a "Progress Report" in 1911, it was noted that there was a growing tendency toward the use of indirect lighting, and especially of semi-indirect. Prismatic glassware and dense glass reflecting bowls were illustrated. In the years just prior to World War I more space was devoted to other phases of illumination than to office lighting in the published record, but the quest for quality continued all the same. Fixture design yielded more to the requirements of efficient and economical illumination, and reflected the current recommendations of the illuminating engineer. Meaningless ornamentation faded from the picture.

Though not specifically connected with the quest for quality in offices, many papers published in this period had a strong bearing on the quest. Basic information was obtained from the studies by Cobb on "Psychological Points Bearing on Glare," by Black on "Artificial Illumination as a Factor in the Production of Discomfort," and by Cravath, on "Lighting of Small Rooms." Another fundamental paper of Percy W. Cobb was of dual importance. This was "Vision as Influenced by Surroundings," reporting basic data developed under carefully-controlled laboratory conditions. It demonstrated that the eye does choose to function best in a balanced-brightness environment. Such a paper was more valuable than a whole volume of the quasi-factual reports which had been the previous foundations of office application thinking.

Before leaving the record for this period, it is interesting to note T. W. Rolph's recommendations (1912) for quality lighting equipment. In philosophy and in actual values, they are startlingly similar to some of the most respected today:

(a) The flux below 60° from nadir should not exceed 6 per cent of the total.

(b) The downward flux should not exceed 15 per cent of the total.

(c) The candlepower of the luminaire from 60° to 105° should be low.

(d) The candlepower from 105° to 145° should be a maximum with a reduction toward 180° so as to provide a uniform brightness pattern on the ceiling.

Despite the country's preoccupation with "winding up the watch on the Rhine" and supplying our doughboys over there, the quest continued during World War I. Happily, it was now a much more directed search than the groping of the previous decade. Actual installations were put in for study, and the Society's Transactions duly disseminated a growing literature for the guidance of those to come. Illumination levels still ranged up to about 5 footcandles, but office lighting practice aiming at improved quality met with wider and wider acceptance.

Most mid-century engineers are born and raised with a full appreciation of the advantages to a lighting installation of high-reflectance light colors for walls and ceilings (to say nothing of other surfaces). So it may seem odd to find that it was big news in 1917 that more light could be obtained on a desk using light cream rather than "green" walls, and that an "ivory white" ceiling raised semi-indirect desk illumination 11.6 per cent; further, if the walls too were cream, the increase was 31.7 per

cent. A major paper published at the time reported these important findings.

A notable advance toward our present knowledge was provided by another paper of the time: the Harrison-Anderson "Coefficients of Utilization." Presented in October 1919, it was published in 1920 with a color chart showing reflectance values of colors and finishes likely to be encountered in practice at that time. This paper gave all general lighting fields a practical system for predetermining quantity of illumination. This same year, Harrison's paper "Glare Measurements" furnished another milestone in the quality quest as well. Nine types of lamps or lighting units were rated by a group of observers by setting a comparison target 3½ inches in diameter at a brightness that gave "equal discomfort." As several discussors noted, this paper introduced the concept of "discomfort" glare, and identified both brightness and total flux (area times brightness) as contributing factors.

By the time that office workers were referred to as "her" instead of "him" in articles on the subject, authors of papers in the Transactions were talking in terms of 20 or so footcandles, and giving some thought to permissible limits in brightness contrasts. This was in the middle 1920s. Three members contributed a paper each to a Symposium on Office Lighting, which took ten pages in the Transactions. Discussors filled twenty-three! It was as if the office field had been rediscovered as the sounding board for the Society's Quest for Quantity and Quality Lighting.

Modern Office Lighting

It seems proper to designate the twenty-five years between 1930 and 1955 as the "modern" period in office lighting. With documentation available on lighting principles, what to aim at, what to avoid, engineers in this period devoted their efforts to getting the higher levels they now knew were required — with comfort. Many techniques commonplace in 1956 were first conceived in the early thirties. In 1930 a built-in architectural lighting system employing large luminous panels in an engineering office, provided relatively high illumination levels with low brightness. Although its high cost was considered a stumbling block, the installation was hailed as a practical and definite contribution to the lighting art. The principle of slanted louvers was introduced in 1932, to prevent reflected glare from extended light sources in drafting rooms. In the same year an "Educational Bookcase" was developed for lighting private offices to about 40 footcandles by means of five 1000-watt floodlight lamps mounted on top of the bookcase above eye level, in a parabolic aluminum reflector directed at the ceiling.

Such installations were hardly routine, of course; in a vast majority of offices the glass enclosing globe, now scornfully referred to as "the glare ball," was standard equipment. But the thinking and efforts of the office lighting engineer were definitely what we would term modern.

Indirect lighting, often with silver bowl lamps, was the "last word" in the middle thirties, but not in the minds of some engineers. There was a growing consciousness of the need to eliminate the high ceiling brightnesses inherent with high level indirect systems. The problem was the subject for full discussion at the 1935 I.E.S. Convention, and apparently started a trend toward "downlights" of various types. Installations stemming from this kind of discussion are now quite easily recognizable as near relatives to current practice. In one installation of that period, silvered bowl lamps were installed in the centers of four-foot square coffers which were 1½ feet deep. The neck of the lamp was shielded by a ring of plastic or metal. Result: low ceiling brightness and good utilization.

By 1935 it had become apparent that it was difficult to provide more than about 50 footcandles of indirect lighting comfortably. Some authorities, in fact, considered 30 footcandles of general indirect lighting to be a practical maximum unless considerable care were employed. Twenty footcandles was considered to be a reasonable minimum for general lighting, before adding local lighting. The I.E.S. Study Lamp, developed by the School Lighting Committee in 1934, was often used as supplementary lighting to provide higher levels on work areas. Lighting engineers, however, were already working to provide other solutions to the problem.

Just as early seekers of practical lighting data used their own homes to try out their "crazy" ideas, many executive offices in the thirties proved to be testing grounds for new lighting methods. In one such office, a very comfortable 60-footcandle system was installed by constructing a ceiling of oxidized aluminum in the form of three large troughs, parabolic in section, with a succession of lamps placed along the focus and shielded from view. This was only one of a number of experimental installations which must have seemed fantastic at the time. But they provided, as nothing else could, practical, usable techniques to solve the quest for quality.

Experimental installations revealed, for example, that a combination of direct and indirect lighting

resulted in more comfort than did totally indirect, and had fewer shadows than a totally direct installation. It was further shown that louver shielding of the direct luminaires was more comfortable to view than diffusing glass. In one instance, indirect cove lighting was combined with recessed, louvered direct luminaires to obtain a general illumination level of 30 footcandles.

Another step in the trend toward lowering the ceiling brightness without impairing utilization was a stamped metal ceiling employing the Fresnel principle to reduce the depth of the parabolic contour. An aluminum paint finish enabled the parabolic sections to direct the light from indirect luminaires downward instead of toward the eye. All this was "B. F.," before fluorescent.

The fluorescent lamp was a wonderful new tool for the illuminating engineer, but as we all know, it's lower-brightness-surface notwithstanding, the quest for comfort was not automatically solved with its development. Fixture design to accommodate it went through an evolution of its own, ranging from a single bare lamp, to single-lamp luminaires with 45-degree louvers. Types we recognize as current came quickly, however. In 1941, for instance, two-lamp 100-watt fluorescent luminaires were suspended 24 inches below the 9-foot 9-inch ceiling of a drafting room to obtain what was probably the first sizable indirect fluorescent installation. The illumination level was 43 footcandles after 200 hours. Before that year was over, several types of semi-indirect and direct-indirect fluorescent luminaires were available with either louvers or diffusing panels beneath the lamps. Experience had already shown that the diffusing glass enclosures first employed, were little, if any, better than bare lamps. A luminaire output of about 70 per cent was considered to be a reasonable efficiency.

The forerunner of the currently popular large area surface units was also installed in 1941. It consisted of a custom-built, large area, luminous element concealing fluorescent lamps and was so installed between large beams and ducts that the luminaire appeared to be part of the building. An illumination level of 75 to 100 footcandles was provided.

In this period most good fluorescent installations provided about 50 footcandles, and the use of continuous rows was becoming popular. It was also about this time that the 45-degree layout was introduced for drafting rooms. The experience gained from the numerous troffer installations which had now been made, showed that the closer the spacing between troffers, the more comfortable the installation was likely to be. This gave lighting engineers a new outlook. They could now provide higher illumination levels without di[illegible]mfort, instead of being limited to 40 to 50 footcandles as with filament lighting.

Progress was not limited to electric lighting. Glass blocks were finding increased acceptance as a means of controlling fenestration brightness. Extensive illumination design data for both clear glass and glass block fenestration with various types of controls was made available.

Studies of reflected glare, shadows, and visibility led to a better understanding of drafting room problems and started a controversy which has continued to this day. On the one hand it was claimed that the newly introduced luminous indirect fluorescent lighting was an ideal solution to drafting room lighting problems; on the other it was stated that the reflected glare studies indicated that the reflected brightness of the ceiling would act as a veiling brightness on the task, thus materially reducing its visibility. Indirect and luminous ceilings, it is contended, do not eliminate this "imperceptible" but real veiling glare. To dispel the argument, a meter or technique is needed to measure the effect.

An artificial skylight 12 feet by 28 feet at a 21-foot height provided an average level of 65 footcandles in a drafting room and could be considered to be a 1942 version of the currently popular luminous ceiling. A predecessor of today's large area luminaires also appeared over the desk in a private office in the form of a four-foot square recessed element with Alzak aluminum louvers shielding five fluorescent lamps.

First Recommended Practice

In September 1942 the first I.E.S. Recommended Practice of Office Lighting was published in ILLUMINATING ENGINEERING. Prepared by the Committee on Lighting Practice, the new Recommended Practice was so well written that much of the material is still employed in the current edition. Profusely illustrated, it showed a good cross section of the types of lighting in use at that time. Included were illustrations of a drafting room with an installation of fluorescent troffers in a saw-tooth ceiling so oriented that the troffers were almost completely concealed from the draftsmen's view, large area units, parabolume ceilings with indirect incandescent luminaires, and a method of translighting to simplify tracing work in drafting rooms.

World War II limitations tended to slow progress on office lighting although the war did stimulate the use of fluorescent lighting in war industry

Some Current Office Lighting Systems

Direct-indirect two-lamp (40T17) louvered luminaires mounted in tandem are suspended 16 inches from ceiling (50 ft-c).

offices and draftng rooms. The increased use of windowless buildings for such offices also provided a stimulus for better lighting installations since they provided the only illumination. URC and other such types of office lighting fixtures were another war-time development, stemming directly from the restrictions on metal during that period.

The end of the war permitted more emphasis on office lighting, and rapid strides were made in both the design and use of office lighting equipment. Among the outstanding developments were the practical systems of predetermining the relative comfort of proposed installations. The advantages of using conventional lighting equipment in functional layouts in small offices were more fully explored with the result that such layouts became common practice.

High illumination levels in the order of 75-100 footcandles also became more common, and by 1947 several installations providing over 200 footcandles were reported. One such installation consisted of well-shielded aluminum troffers having a brightness of only 20-30 footlamberts crosswise and a maximum of 300 footlamberts endwise. Despite this low luminaire brightness, it was found that the installation was comfortable only when *all* room surfaces including desk bodies and kneeholes as well as the tops, cabinets, doors, files, etc. were finished in light colors to minimize brightness differences between the bright task and these surfaces. The "louverall" type of ceiling introduced in 1946 offered another practical means of providing extra high illumination levels, and many variations soon became available with aluminum, painted steel, plastic, and even wooden louvers being employed to form various sizes and shapes of cells.

Second Recommended Practice

The revised Recommended Practice of Office Lighting published in July 1947 was the first Lighting Practice prepared by the Committee on Office Lighting. It included a much more comprehensive section on daylighting techniques and controls than the 1942 Practice and reflected the progress in electric lighting — particularly fluorescent — that had occurred since 1942.

The trend toward higher illumination levels emphasized the importance of light desk tops, and by 1949 desk grade linoleum with a reflectance of 30-35 per cent was readily available. In fact, the U. S. Navy Department standardized on a gray linoleum desk top having 30 per cent reflectance.

Although isolated examples of luminous ceilings have been reported, actually it was not until about 1949 that they became available in a form that made common usage practical. Continued improvements in diffusing materials, methods of installation, and the addition of accessory shielding and acoustical devices over the years up to the present have increased their popularity to a point where such installations are commonplace. Mass production techniques have decreased the cost of luminous ceiling installations, and economies were also real-

Parabolic aluminum troffers combined with luminous panels (100 ft-c).

Plastic coffers, four feet square, mounted 24 inches below slimline lamps on 18-inch centers (50 ft-c).

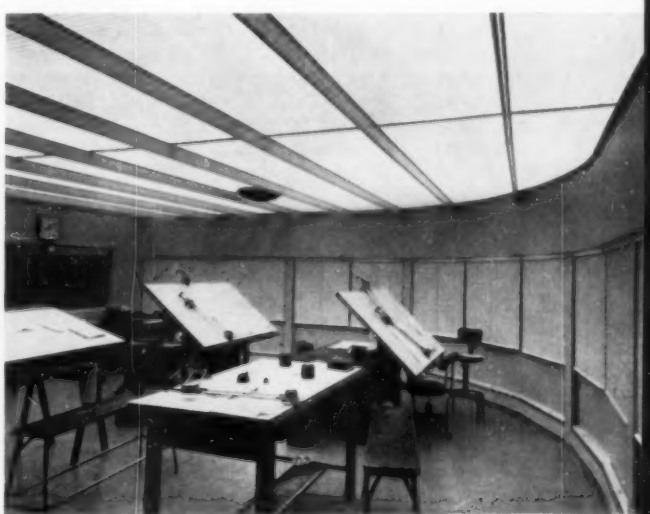
ized with the elimination of the need for a suspended opaque ceiling to conceal ducts, etc.

The luminous ceiling seemed, in some respects, to answer the lighting engineer's dream of a uniform low brightness source that enabled him to provide high illumination levels without discomfort. His quest for quality was not, however, to be fulfilled that easily. Like his earlier lighting "tools" he found that it had to be used with discretion and within limits. Furthermore, the architect's esthetic requirements demanded more variety and versatility than the luminous ceiling offered.

This led to the development of the currently popular large area luminaires. These luminaires are available for either recessed or surface mounting and are generally provided in 1 by 4-foot, 2 by 4-foot, 4 by 4-foot, and 2 x 2-foot elements which may be installed individually or butted together to form elements of any size desired. They may be provided with louvers, glass, or diffusing plastic bottoms.

Concurrent with the increased popularity of

Acoustical baffles and air-conditioning outlets with luminous ceiling of acrylic plastic panels (75 ft-c).



Vinyl plastic luminous ceiling with acoustical baffles (75 ft-c).

Some Current Office Lighting Systems

Plastic louverall ceiling in a private office (75 ft-c).

Deep wooden louvers, 12 inches square, 9 inches deep, one inch thick, tinted light green, are used to conceal 96T12 slimline lamps on 24-inch centers, 20 inches above the louvers. Downlights are used in the window alcove; portable lamps for accent.

Standard fixtures provide custom effect with two 2-foot by 8-foot luminaires each side, one 2-foot by 6-foot each end on short stems. False ceiling in the center adds to the effect. Four T12 fluorescent lamps are used in each unit, with 200-watt silvered bowl lamps in the downlights over the table.

Corrugated aluminum ceiling with troffers. Some of the troffers (two F96T12 lamps per unit) are shielded with deep Alzak aluminum louvers, others with low-brightness prismatic glass (60 ft-c).

In three continuous rows, semi-indirect luminaires are suspended 24 inches from single-stem hangers. Each unit uses four 40-watt white fluorescent lamps (75 ft-c).

luminous ceilings and large area elements there were notable advances made to improve the quality of the lighting from installations of conventional fluorescent luminaires. Side panel brightnesses were reduced, tighter louver shielding was employed, and prismatic glass and plastic troffer lenses were developed to provide brightness control in all viewing directions. A growing awareness of the need for minimizing reflected glare resulted in somewhat greater acceptance of semi-indirect and indirect fluorescent luminaires, but the trend toward lower ceiling heights has tended to decrease the use of all types of suspended luminaires.

One of the earliest types of fluorescent luminaires for offices was combined with one of the most recent forms of lighting in 1951 when a luminous ceiling was installed in the spaces between rows of troffers. In this instance the troffers provided 90 of the 100 footcandles, and the luminous ceiling served chiefly to reduce the brightness difference between the troffers and the ceiling.

On the occasion of the Society's fifteenth birthday in 1922, Dr. Louis Bell took a backward glimpse, and summed up progress in lighting to that point with these words:

"Not a single topic was discussed at the first convention which would not be fully pertinent now and from which, making due allowance for the change in sources, valuable lessons could not be learned. On the other hand, there is not a paper for the coming convention which would have taken the earlier ones quite unawares. The changes in the past fifteen years have been in material rather than in methods.

"As efficiency of sources has risen, so has the necessity of better diffusion, even at the cost of efficiency, become imperative. At the present moment, we are just at the phase of change which requires the abandonment of many of the old popular shades and reflectors in favor of newer forms suiting the brilliancy and dimensions of the new units."

Dr. Bell's summary, if delivered in commemoration of the Society's fiftieth anniversary, would be appropriate in many areas of office lighting knowledge — would miss the mark in many others. Much has been accomplished. Much needs yet to be done in the "Quest for Quantity *and* Quality Lighting in Offices."

STREET LIGHTING

Then and Now

LITERALLY dozens of different light sources were in use for street lighting, back in 1906. As an example, on January 1st of that year, the city of Chicago alone had in service some 5500 gasoline lamps, 12,000 flat-flame gas lamps, 12 500 gas mantles, and 7000 electric arc lamps. In addition to these sources, naphtha or oil lamps were still being used in some parts of the country. In a few places — very few — the new incandescent filament lamps had been installed.

During the past fifty years there has been an almost unbelievable amount of progress in the art of night-time street illumination. In the period in which the automobile has gone from the horseless carriage to the Thunderbird, street lighting sources have progressed from the most elementary forms to the present modern high intensity filament, mercury vapor and fluorescent electric lamps. Some of those old light sources were mounted on low posts, as low as 10 feet. Some were on very high towers, some even as high as 250 feet. The aim, of course, was general illumination, without any special control of the light pattern.

This is very different from today's practice. Now we have scientifically controlled street lighting in most of our cities and on many of our major thoroughfares. Distribution of light is carefully thought out. Greatly reduced night-time traffic accidents have been the most practical result.

The turning point occurred in 1924. The International Commission on Illumination recommended an international study of street lighting, with the findings to be presented at the next meeting of the Commission. About the same time, the National Bureau of Standards requested the cooperation of the Illuminating Engineering Society in the development of a circular on street lighting.

I.E.S. Committee Formed

With this encouragement, in January of 1925, the Council of the Society voted to organize a committee on street lighting. Composed of representatives of electric service companies, laboratories, electrical manufacturers, municipalities, universities, and consulting engineers, this committee published its first street lighting pamphlet in 1928 as the "Principles of Street Lighting." In 1930, it published the first "Code of Street Lighting." Since that time, this committee of the Society has been continuously active in providing up-to-date recommendations for the design and installation of street lighting systems.

The importance of this I.E.S. service is shown in a 1949 survey of the Edison Electric Institute indicating that more than 90 per cent of the companies reporting used the Society's recommended practice as a basis for their own street lighting layouts and recommendations. Reports from many American cities indicate that new street lighting systems now being installed will equal or better the I.E.S. recommendations, and several cities can now report that all of their streets have been lighted to conform to the latest American Standard Practice for Street and Highway Lighting.

This wide acceptance of I.E.S. recommendations demonstrates a unanimity of opinion that was lacking when the Society's street lighting committee first met. In its initial report, the committee said,

Historical Development of Electric Lamps for Street Lighting

A summary of the improvements that have been made in electric street-lighting sources. Descriptive material on the older sources may be found in "Street Lighting Practice," by Harrison, Haas and Reid (McGraw-Hill, 1930).

Lamp Description	Date	Rated Life for Street Lighting Service	Initial Lumens Per Watt
Arc			
Open carbon-arc	1879	Daily Trimming	—
Enclosed arc	1893	Weekly Trimming	4-7
Flaming arc			
(Open)	——	12 Hours	8.5 (d-c multiple)
(Enclosed)	——	100 Hours	19 (a-c series)
Magnetite (d-c series "luminous arc")	1904	100-350 Hours	10-20
Filament			
Carbonized bamboo	1879	——	2
Carbonized cellulose	1891	——	3
Metallized (GEM)	1905	——	4
Tantalum (d-c multiple circuit)	——	——	5
Tungsten (brittle)	1907	——	
Drawn-tungsten	1911	——	9
	1913	——	10
Mazda C (gas-filled)	1930	——	14-20 (varies with lamp size)
	1915	1350 Hours	10-20
	1950	2000 Hours	16-21
		3000 Hours	16-20
Mercury Vapor			
Cooper-Hewitt	1901	Indefinite	13
H400-A1 (formerly A-H1)	1934	1500 Hours	35
	1952	6000 Hours	38
H400-E1 (formerly E-H1)	1947	3000 Hours	50
	1952	5000 Hours	50
Sodium Vapor			
NA-4 (10,000 lumen)	1934	1350 Hours	50
NA-9 (10,000 lumen)	1935	2000 Hours	56
	1952	4000 Hours	55
Fluorescent			
F100T12/CW/RS	1952	7500 Hours	52

"It became apparent at the first meeting of the Committee that its members entertained divergent views on the fundamentals of street lighting. The Committee has therefore addressed itself largely to the task of self-education in street lighting, hoping thereby to reconcile the more divergent views and to approach a consensus of some of the fundamentals underlying street lighting design."

There is little doubt that some of this divergence of opinion could be traced to the rapid development of new and improved light sources and the attendant fact that many different sources were suited to practical application at any one time. The history of the development of these sources and of their application is the history of street lighting.

Oil to Gas to Arc

The first systematic street lighting made use of oil lamps. While there seems to be no record of the "where" or "when" of this initial application of artificial sources of light for the illumination of streets, in July of 1895, the city of Washington, D. C., still had 800 naphtha or oil lamps in service.

Baltimore, Maryland, was the first city in America to have gas street lighting. In 1816, the Gas Light Company of Baltimore was founded to manufacture gas for street lighting and general use, and lighting equipment was installed on the streets during the following several years. Soon after this, the use of gas for outdoor lighting became general.

As several cities claim the first electric street lighting systems, it is difficult to select one for the honor. Nevertheless, it is fairly well established that carbon-arc lamps were installed in the public square of Cleveland, Ohio, in 1878. A feature article in the *Cleveland Leader* of July 22, 1896, recalled the earlier installation: "Twenty lamps were hung about the square and a great crowd gathered to see the display, many wearing smoked glasses in anticipation of a blinding glare."

The *Leader* article further reported that in 1881 four steel masts, one 256 feet high and the others almost as tall, were erected to carry crowns of arc

Figure 1. Gas lighting, flat-flame or with mantles, is almost a symbol of the era fondly referred to as "the turn of the century." It was, however, only one of the numerous light sources in use for street lighting in 1906. The gas light shown is the original unit installed before the War Between the States, still in use in Atlanta, Georgia. Plaque commemorates the Old Guard Battalion of the Confederacy.

lights. But by 1893, because of their obvious inefficiency for street lighting, three of the towers had been removed and the remaining one cut down 100 feet.

Records show that many cities installed carbon-arc lamps on towers from 90 to 165 feet high during the next few years. While most of these towers were removed from service by 1918, the city of Austin, Texas, is still lighted by "artificial moonlight" from 165-foot towers. On the theory that it was easier to light a large area with one tower than to erect street lights in hilly, undeveloped areas where streets were unpaved and travelling dangerous, Austin erected 31 of the 165-foot towers in 1895. Each tower supported six arc lamps. The arcs were later replaced with filament lamps, which, in turn, surrendered to 16,000-lumen mercury vapor lamps. Twenty-seven of the towers, each bearing six mercury lamps, are still in service.

Edison's Contribution

It is possible that the first practical demonstration of the carbon filament incandescent lamp was also the first use of electric filament lamps for street lighting. A description of Edison's public demonstration at Menlo Park on New Year's Eve, 1879, reported that some 60 lamps were mounted on poles in the laboratory grounds and along adjacent streets.

Figure 2. In Chicago alone, some 5500 gasoline lamps such as this were in street lighting service when I.E.S. was young.

Figure 3. Horse-cars made their way up Yonge Street in Toronto, Ontario, by the light of arc lamps. Picture is of the first arc-lamp installation in Toronto, in 1890.

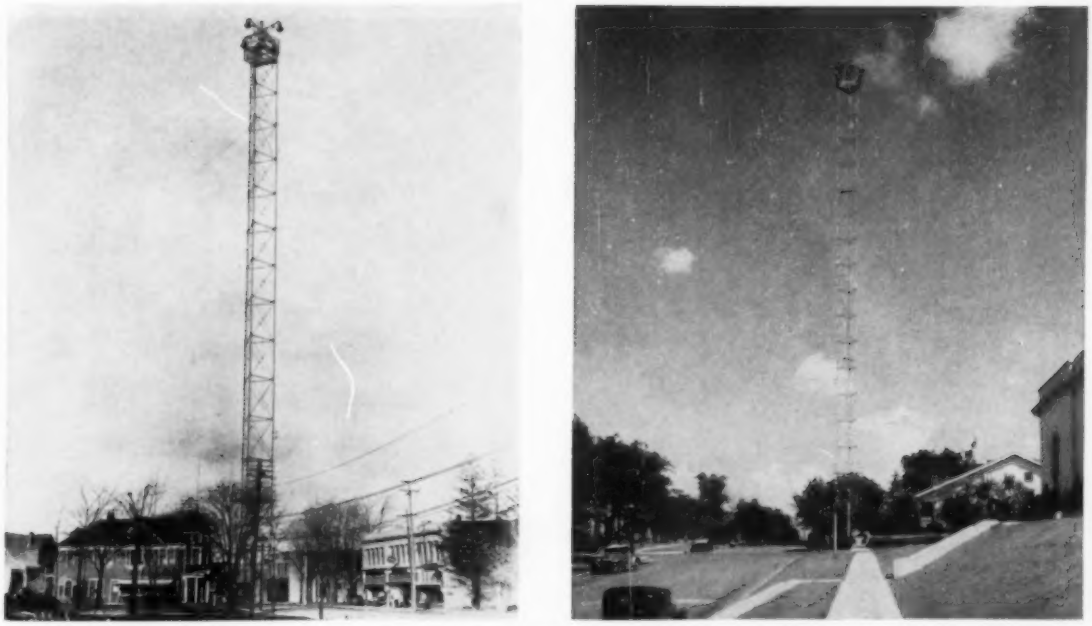


Figure 4. Early electric sources were frequently mounted on very high towers, a height of 250 feet being not unusual. Twenty-seven such towers in Austin, Texas are still in use but the arcs have now been replaced with six 16,000-lumen mercury vapor lamps per unit.

Flint, Michigan, in 1899, installed a unique filament lighting system of thirteen iron arches, each bearing 50 lamps of various colors, to light its main street. The arches remained in service until 1917, when they were superseded by a new boulevard lighting system.

Interest in gas lamps for the lighting of streets received new impetus in 1885 with the development of the Welsbach incandescent mantle. The gas mantle made possible a lamp producing 60 candlepower compared to the 20 candlepower produced by the flat or open flame. Both used approximately the same amount of gas.

In 1906, the magnetic direct-current luminous arc lamp made its first appearance as a street light source. Producing a comparatively steady light,

Figure 5. Another method of street lighting 50 years ago. Thirteen iron arches, each bearing 50 lamps of various colors, illuminate the main street of Flint, Michigan. This system saw service till 1917.

Figure 6. Magnetite Arc lamps saw wide service for street lighting for many years. In residential districts they were often suspended from beautifully wrought iron poles; sometimes single units, frequently as double units or in clusters. In the business districts they were hung on wire in the center of the street, suspended from arms on telephone poles or mounted high on special posts. Arc lamp street lighting was in use in some communities well into the thirties.

the magnetic arc was more efficient and cheaper to operate than any of the previous arc lamps. Trimming of the electrodes was reduced to two or three times per month. Luminaires using reflecting and diffusing elements were developed for both utilitarian and ornamental applications. The magnetic arc was considered a satisfactory source for many years, and as late as 1928, ornamental systems using the 6.6-ampere magnetic arc were installed in Washington, D. C.

Tungsten Filament Introduced

The tungsten filament lamp was the first incandescent light source to appear as real competition for the arcs. First manufactured in America in 1907, the lamp operated with greater efficiency than the previous incandescent lamps and was available in a variety of sizes. About 1908, some communities began lighting their business districts with strings of incandescent filament lamps suspended across the street at frequent intervals, an installation technique described at the time as "not only decorative, but also produces a fairly uniform illumination throughout the business section."

During the next few years, the cluster type of street lighting post began to appear in many business areas. In December of 1910, Atlanta, Georgia, celebrated the lighting of the "Brilliant Lights of Atlanta's Great Light Way." The *Atlanta Georgian News* of December 15, 1910 devoted the entire front page to photographs and descriptions of the new street lights and the plans for the celebration.

Toronto, Canada, was one of the first large cities to replace their arc lights with filament lamps. According to a report, "On November 1, 1911, the 1,700 arc lamps were replaced by a unique and elaborate street lighting system consisting of cylindrical lanterns mounted at a height of nine and one-half feet above the ground. All main thoroughfares and business sections were provided with lamps on both sides of the streeet spaced 100 feet apart."

Figure 7. An historically important event in street lighting practice was the installation made in Milwaukee in 1916; its design was preceded by the most extensive, detailed study of street illumination which had so far been undertaken, and it represented one of the earliest designs based on scientific data. Distinguishing feature of the system was the use of refractors for calculated control of the light, together with high mounting heights.

To give some idea of the numbers and varieties of sources in use at this time, it can be reported that on July 1, 1915, the city of Washington, D. C., had in operation some 10,000 gas mantles, 1,000 electric arcs, and 6,900 electric filament lamps.

The Panama Pacific Exposition of 1915 turned San Francisco's Market Street into a path of gold with a spectacular street lighting system. Ornamental poles, 10 to 12 feet high, with underground service and close spacing, supported moderately high wattage incandescent lamps enclosed in yellow tinted glass globes. This was the first consideration of color in street lighting.

The year 1915 also marked the introduction of the gas-filled tungsten filament lamp, with its higher efficiency and whiter light. The gas-filled lamp made production of higher wattage filament lamps economically practical, and new street lighting luminaires, globes, and refractors were designed for these larger sources.

A most significant milestone in street lighting practice was the first installation based on a scientific study of the subject. This occurred in Milwaukee in 1916. Prior to 1914, little, if any analyses were made of actual requirements in the installation of a street lighting system. The Milwaukee system was preceded by the most extensive detailed survey ever undertaken, with a comprehensive report covering requirement-analyses being adopted by the City Council in September 1915. A distinguished feature of the system was the calculated control of light by means of refractors, which decreased the light directly below the luminaires and increased the light at points between adjoining luminaires. This was aided by high mounting heights, which also minimized the glare and blinding effect. The system in many respects complies with the requirements of the present "American Standard Practice for Street Lighting," particularly as to mounting heights and light distribution patterns.

Figure 8. One development which saw wide service was the use, singly or in clusters, of the tungsten-filament lamp with radial wave reflector. The installation here is with 60-watt lamps on a high ornamental iron pole.

Figure 9. Hartford, Connecticut has a long history of forward-looking street lighting planning. This was new in 1914; twin unit with two 6000-lumen lamps in alabaster globes mounted on cast iron post, 14½ feet tall.

Figure 10. Though concrete poles had their start around 1910 (with ball globes), they were frequently used with the harp-type fixture shown, about 1918. The lamp is low-wattage incandescent.

Figure 11. Some variation of the alabaster bowl unit, with a single unit (below), or with a multiple cluster (right), was a familiar street sight during the twenties. They may still be found in some communities, but no longer with the 60-watt incandescent lamps first employed in them.

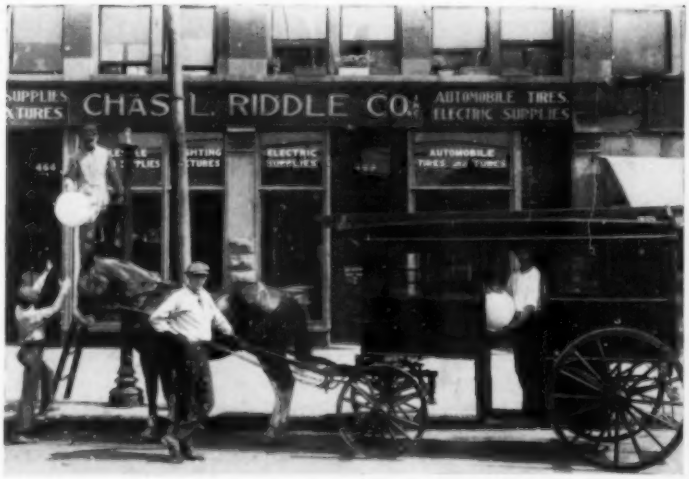


Figure 12. Three men and a boy cleaning street light globes, June 1919. Note the low-mounted low-wattage lamp used in these units.

World War I interrupted most street lighting programs in 1917, but about 1920 construction seemed to get back into full swing. Many new installations were made in business districts and newly developed subdivisions using a taller, slender standard with the lamp enclosed in a rather simple globe or lantern. It was in the early twenties that many utilities and municipalities began to replace their electric arc systems with the more economical incandescent filament lamp.

I.E.S. Tackles Street Lighting

As mentioned above, it was in the 1920's that the Illuminating Engineering Society added the lighting of streets to its technical investigations with a possible code of recommendations as a goal. The first report of the Society's Committee on Street Lighting, in 1926, described the committee's attempt to develop a system for evaluating the effectiveness of street lighting. The committee's 1927 report described the elements of effectiveness and a method by which individual installations could be appraised. In 1928, the Society published "Principles of Street Lighting," and in 1930, a "Code of Street Lighting."

During the period from 1925 to 1930, many communities installed high intensity "white way" street lighting in their business sections. Most of these systems used poles 20 feet or more in height, supporting expensive ornamental luminaires. Many of the poles were heavy with ornamentation. While most "white way" systems used high-wattage incandescent filament lamps, a few magnetite arc lamps were still being installed.

During the early and middle thirties, improvements in light sources and luminaire design led to substantial changes in existing theories of street lighting. In 1930, an improvement in gas-filled filament lamps made possible an efficiency of 20 lumens per watt in the larger sizes. The first mercury vapor lamp, rated at 400 watts, 1,500 hours life, and 35 lumens per watt, became available for street service in 1934. This same year, a 10,000-lumen, 50 lumen per watt, sodium vapor lamp made its appearance.

Figure 13. Higher mounting (of the order of 30 feet) and higher candlepower lamps (1000-cp) were a notable advance.

Figure 14. Street lighting engineers have conducted almost continuous studies over the years, in the development of current street lighting recommendations. The scale-model street shown here was one of the methods of testing techniques.

New luminaires were designed for these light sources, many of them incorporating the recently developed Alzak aluminum as a reflector. Even today, Alzak remains one of the most efficient reflecting surfaces available to the lighting industry. Better glassware, both globes and refractors, was designed to reduce the glare of pendant type luminaires. The new luminaires were created for higher mounting heights, 25 to 30 feet or more. With their improved light pattern to produce a more uniform pavement brightness, these units had a higher utilization efficiency and were easier to install and service than the designs they superseded.

Light and Traffic Safety

About this time, many people were becoming aware of the seriousness of the street and highway accident toll. One result of this awareness was the beginnings of investigations to determine the part good street lighting could play in accident reduction.

During the years of 1936-37, the Detroit Public Lighting Commission installed some 31 miles of improved street lighting, using the newly designed high efficiency luminaires on sections of heavily travelled thoroughfares where night traffic accidents were the greatest. Extensive traffic accident studies were made both before and after this improved lighting was installed. Several reports showing the results of these studies were presented. See *Transactions of the I.E.S.*, Vol. XXXII, No. 10, December 1937 "Saving Lives with Light"; also *Transactions of the I.E.S.*, Vol. XXXIII, No. 8, September 1938 "Street Lighting and Safety." The records show that the improved street lighting greatly reduced the number of traffic accidents and saved many lives.

Hartford, Connecticut, started a relighting program in 1936, installing improved equipment on 33 miles of city streets. Comprising about 15 per cent of the city's street mileage, these streets carried nearly 40 per cent of Hartford's traffic. On December 9, 1947, the Connecticut Highway Safety Commission reported on the streets relighted in 1936: "During the 10-year period, July 1, 1937 to July 1, 1947, there was a 76 per cent reduction in night fatalities, a 78 per cent reduction in night pedestrian accidents, a 71 per cent reduction in night car-occupant injuries, and a 58 per cent reduction in all types of accidents."

Pavement Reflection Studies

In 1934, the Committee on Street Lighting of the Illuminating Engineering Society began a series of studies concerned with the improvement of pavement reflection. One of the first results of this was the paper, "Surfacing Asphalt Pavement for High Night Visibility" published in 1939. The information obtained from the reports of these studies was of considerable help in the preparation of the first "Recommended Practice of Street Lighting" published by the Society in 1940. This work was a complete revision of the earlier I.E.S. street lighting codes.

A new line of multiple service filament lamps rated in nominal lumens instead of watts was designed especially for street lighting service and introduced in 1940. These lumen-rated lamps enabled utility companies to place their street lighting rates on a lumen basis. Two types were available: the standard lamp with a rated life of 2,000 hours, and a group replacement lamp with a rated life of 3,000 hours. Similarly rated series service lamps were also made available.

Throughout World War II, street lighting was at a standstill. Materials were impossible to obtain, and the only construction work permitted was that necessary to maintain existing systems. Blackout and dim-out conditions were either in effect or on a stand-by basis in most parts of the country, con-

A

B

C

D

Figure 15. I.E.S. recommended practice is the basis for a vast majority of current street lighting layouts and recommendations in this year of 1956. Typical of current practice is the mercury vapor unit (A) in Hartford, Conn. and (B) in Washington, D. C., and the fluorescent street lighting unit (C) in Atlantic, Iowa, and (D) in Hopkins, Minnesota.

fronting street lighting engineers with new and urgent problems. The I.E.S. and members of its committees were kept busy cooperating with federal, state, and municipal officials in all phases of war-time lighting.

Post War Recommendations

Shortly after the war ended, the Street Lighting Committee submitted to Council a 1945 edition of the "Recommended Practice of Street and Highway Lighting." With a few revisions, this Recommended Practice was approved by the American Standards Association and became, in 1947, the first "American Standard Practice for Street and Highway Lighting." Among the new recommendations contained in the 1945 edition were greater mounting heights for luminaires, a minimum lamp size of 2,500 lumens, and the classification of luminaires into five lateral light distributions.

The E-H1 mercury vapor lamp was introduced in 1947 and was followed shortly by street lighting luminaires designed especially for it. A trend to mercury street lighting developed rapidly in many parts of the country, and it gained momentum in

1952 when new developments increased the life of both the E-H1 and A-H1. In the last few years, the color quality of the characteristic blue-green mercury light has been improved by a coating of red-fluorescing phosphor on the interior of the outer bulb. The modified lamps have been made available in 400-, 700,- and 1000-watt sizes, while regular, clear mercury lamps are available in a range of sizes from 100 to 1000 watts.

Fluorescent street lighting studies were made in 1945 by the I.E.S. Street Lighting Committee and trial installations in Detroit, Cleveland and Schenectady were observed. These early attempts at adapting the fluorescent lamp to street lighting demonstrated only that such a system would be economically unacceptable with the lamps and luminaires then available. However, in 1952, a new high-output fluorescent lamp with improved low temperature operating characteristics was combined with a new type of luminaire to make fluorescent street lighting practical and attractive. Oakwood, Ohio, was one of the first towns to use this equipment, with an installation made in December of 1952. Since that time many other communities have lighted their business districts with fluorescent luminaires. Fluorescent lighting, in luminaires and systems of special design, has been particularly successful in the lighting of tunnels and underpasses.

And of the Future?

This, then, is the history of 50 years of street lighting. Today it is estimated that there are from four and one-half to five million street lights in service in the United States, and the projection for 1966 is twice that number — 10 million. Most of the sources in use today are filament lamps. Further estimates place the number of mercury lamps in service at 400,000, and the number of fluorescent units at from 10,000 to 12,000, not including those used for tunnels, underpasses, bridges, or viaducts. It is predicted that 10 years from now at least one-half of the lumens provided for street lighting will be from gaseous discharge sources—either mercury or fluorescent lamps.

During the past few years, the study of street lighting has been on more and more of a scientific basis. Reflecting this, the latest American Standard Practice for Street and Highway Lighting, published in 1953, represents considerable refinement in the classification of luminaire light distributions, improved treatment of forestation relationship, expanded computation and design data, and more detailed techniques of measurement.

The new Standard Practice is now considered the primary resource for street lighting men. Typical of many comments received is one from L. M. Johnson, Commissioner of Streets and Sanitation, Chicago: "Chicago has approximately 800 miles of arterial streets for which it must provide lighting. Under the present plans they will have installed new improved lighting, meeting I.E.S. recommendations and A.S.A. standards on approximately 336 miles or 42 per cent since the present program began in 1947."

In 50 years, street lighting has come a long way, and the influence of the I.E.S. in street lighting application has continued to grow. Today, new developments in sources and application techniques are coming at a greater rate and in greater numbers than ever before. It seems apparent that the outstanding progress of the past 50 years is a significant but inadequate indication of things to come.

50th Anniversary Issue

Several thousand extra copies of this special commemorative issue of ILLUMINATING ENGINEERING have been printed, and are available on order to the Publications Office, I.E.S. Headquarters.

Residence Lighting

during the last fifty years

ALMOST FROM the outset lighting specialists both here and abroad expressed dissatisfaction with the appearance and the functional effectiveness of lighting fixtures for the home. Notwithstanding the beauty and effectiveness of many individual designs that have appeared during these last fifty years, a running tone of dissatisfaction has prevailed. It opened in the first volume, 1906, of the Society's Transactions. Later in 1925 the Studio Year Book of Decorative Literature (England) said — "There is a great field for enterprise among designers in electric light fixtures and shades but, so far, very little advantage seems to be taken of the opportunities provided. Fixtures obtainable are either direct copies or adaptations of old work. There is probably no branch of applied art in which the scope for pleasing design is so noticeably neglected. People of taste would welcome the appearance of good, simple, moderate priced fixtures, unpretentious in character but with some degree of individuality and distinction." The same journal in 1937 went on to add, "Lighting fixtures are a matter which we all ponder and no wonder, for a trip through the electrical department of any large store is a depressing experience . . . good lighting fixtures are obtainable so why are so many ugly ones offered to us? The true purpose of lighting fixtures — *i.e.*, to give light — seems to have been forgotten in a frantic effort to make fixtures decorative."

Throughout much of these fifty years the specific performance functions of permanently installed fixtures have never fully crystallized for many reasons. Chief among these has been —

(a) the limitation of how many could be acceptably used in a room and
(b) how could light and shade patterns be produced that would avoid uniformity of ceiling, wall and floor brightness while
(c) producing illumination values at specific locations that would be quantitatively related to the values used in certain areas of commerce and industry where comparable visual activities must be served.

It was usually assumed that a single central ceiling fixture, almost regardless of size, could meet every lighting need whether it be for creating a given atmosphere or supplying light for close visual applications.

Attempts to establish various criteria for evaluating the performance of fixtures began formally in 1922 when the Society appointed the "Committee to Cooperate with Fixture Manufacturers" to bring in some form of answer. This Committee produced an informative report — "Tentative Code of Luminaire Design." It was essentially an outline of the principles of lighting fixture design which, when employed by the industry, would bring about product development improvement. It did not establish methods of testing lighting equipment nor did it assign values of performance to them. It was essentially educational and was not accompanied by an action program.

Five years later, 1927, committees of the Society and the Association of Edison Illuminating Companies felt so keenly on this subject that they completed "Fixture Performance Specifications" — which attempted to establish criteria for:

(a) illumination qualities
(b) construction, finish, and
(c) appearance for lighting fixtures.

Both the lighted and unlighted appearance of the fixtures was taken into account.

The evaluation of glare was appraised by directly viewing the lighted fixture while also viewing one or more of five, six-inch diameter, inside frosted, crystal glass globes. Each was equipped with a lamp which ranged from 10 to 50 watts. If the discomfort sensation of the fixtures to be tested was no greater than the globe with the 10-watt lamp, the most favorable glare rating was assigned to the fixture. When the discomfort sensation was greater than the globe with the 50-watt lamp, the tested fixture was not acceptable. Intermediate

Figure 1. Electric lighting in the home

values were assigned for comparisons that fell between the 10- and 50-watt lamps.

In Cleveland — 1927, in Chicago — 1928, and in Pittsburgh — 1931 there were exhibits of fixtures tested and rated under these specifications. Cash prizes or awards were given for the outstanding equipment. Published results containing data on these fixtures were produced each year from 1930 through 1933. A marketing industry program was not developed.

Quite apart from this procedure, one highly regarded illuminating engineer in 1915 suggested that 230 footlamberts was the brightness limit for luminous bowl fixtures.

Some years passed before another attempt was made to devise fixture evaluation methods. However, the Society's Residence Lighting Committee completed a new approach to the subject in 1939 and a final revision of this material in 1940 after several years of study and observation.

Fixtures were classed by types of light distribution and by their decorative or utilitarian value. Minimum illumination values delivered in a prescribed test room were called for and brightness limits were established for various vicinity angles. Also miximum ceiling brightnesses were included.

At this point, the American Lighting Equipment Association adopted these specifications and also engaged the Electrical Testing Laboratories to supply inspection and certification services. Identified fixtures were launched at the commercial level. The Department of Commerce made an award to A.E.L.A. for its achievement in enlisting the interest and support of its own and allied industries in a program of standardization and trade promotion to rejuvenate a depressed market, with beneficial results to manufacturers, distributors and the public. The directly interested manufacturers responded enthusiastically and voted to proceed, embracing the Society's "Recommended Practices . . ." and to key its program to the overall objectives of the lighting industry. World War II prevented a full scale development of a program. The specifications in themselves left much to be desired.

A new attack on the problem by a later committee of the Society began in 1944. Over a period of approximately two years this committee developed the Recommended Practice for the Performance of Portable and Installed Residence Luminaires. This appeared in 1946 and in this instance methods for evaluating both portable lamps and fixtures were included. The methods employed include for the first time, glare evaluation based on both the size of the luminous area of the equipment as well as the brightness. Small areas are permitted higher brightnesses than large areas. In an appendix section of this report, areas to be provided special lighting are described and the most desirable locations for placing certain portable lamps are indicated. These conformed with the specifications of the Certified Lamp Makers. Models of these lamps had been shown in the industry the latter part of 1945. As originally written, this recommended practice embraced a more thorough

when I.E.S. was young.

grasp of the subject than anything that had been done in this field. Except for added work in developing a broader handling of its so-called "Appendix B" (The Functional Visual Activities in the Homes), which was then completed in 1950, no further work has been carried on in the area of lighting fixture specifications.

Portable Lamps

One early style of kerosene table lamps made such a niche for itself, that it is still admired and cherished by those who love certain forms of Colonial and Victorian interiors — reproductions of which electrified, are still being produced.

For producing Low Value eye comfort effects of considerable charm, it stood out in comparison with other lamps of its time. Its large spherical white globe of glass completely concealed the kerosene flame and, of course, resulted in producing softness and high diffusion of light. Its lower sphere of the same glass held the fuel. It was large and important, sometimes 30 inches high and with its overall painted floral decoration gave off qualities associated with the romantic period. It still does when used in conjunction with hidden forms of modern lighting.

Table lamps using illuminating gas were connected to a pipe wall-outlet or an overhead fixture with a flexible hose, thereby affording some flexibility of placement. The basic design consisted of a metal vertical shaft 12 inches to 15 inches high, at the top of which a Welsbach mantle was mounted. Over the mantle a green glass inverted bowl-shaped shade was held in place by a ring of polished brass. The unique element was the green glass shade, since it was two layers thick with its layer of white glass. The latter effectively directed light downward. Since the hot burned gases had to pass up and out of the inner clear glass chimney, a moderate but valuable amount of light also escaped upward through the chimney opening. Since it also included a mantle for improving the color and amount of light for a given amount of gas, this lamp represented a good step forward in functional design. Later designs of table lamps using electric lamps did not always meet all their design potentialities with this clarity.

Since the range of objects, shapes, materials and bases that has been and still is being used is essentially limitless, it is difficult to associate any particular form with the first electric table lamp. Perhaps they were like the gas type design, in which the lamp socket replaced the gas burner. Mission style oak base and shade frames may be noted around 1910. The shade frames carried panels of either red, yellow, green or mottled colors of cathedral glass. Many of these were made by high school boys in their manual training school classes. They were usually closed at the top.

Fabric lamp shades were dark and closed at the top as they replaced the early forms of glass shades. Many were so shallow and large in diameter, that they had to use fringe to create a shielding side element. This fringe made of glass beads,

Figure 2. Demonstration kit carried door to door by "home lighting advisors" did much to stimulate the homemaker's interest in residential lighting during the early thirties.

silk or velvet provided poor shielding of lamp bulbs and the next step was that of adding a flounce of fabric. Most of these flounces were highly colorful; medium red-orange being the favorite. Shade linings matched the flounce color. The shallow shade of dark material with closed top was a difficult form with which to work, since the lining was always harsh and glaring. The dark and dingy room full of excessive contrast was popular.

Floor lamp shafts and bases took on their first great importance, when they appeared as massive carved wood forms, usually finished in dark red mahogany. Fringed shades were common. The largest of these was tall, and wide enough for several adults to stand beneath. The lamp bulbs were arranged in a cluster, from two to five in the top of the shade. These clusters held the lamps either base-up or at an angle from the vertical. Later the sockets were adjustable up and down. No form of diffusion of the downward light was in evidence; very little upward light was available.

In the early 1920's an indirect reflector appeared inside the shade of a limited line of both table and floor lamps. It was supplemented by several bare lamps beneath the reflector. The shade on these lamps was much deeper but even some of these used fringe. The reflecting device used was rather large, hence its application was somewhat limited to large scale rooms and to the homes of higher income since the prices were high. Earlier, a few experimental lamps were made using an opal glass bowl open at the top in conjunction with the lamp bulb burning base down. These lamps used deeper shades, so that good side shielding was indicated for the future.

Shortly after there appeared a completely developed floor and table lamp with an essentially straight side pleated shade without fringe and open across the entire top. Inside the shade was a 10-inch opal glass bowl designed for a 200-watt lamp used base down. The dimensions of this basic table lamp are significant; height 27 inches and bottom shade diameter 16 inches. This lamp introduced good design on all fronts at one time, including lighting qualities, which provided a new order of beauty and eye comfort, even the colors were warm and soft but alive. The entire lamp seemed to be more symbolic of sunshine than anything that had gone before. As has so often been the case, the acceptance of this lamp, while encouraging, was slow. Even the finest piece of portable lighting equipment, when placed alone in a room that also contains much poorer equipment may suffer since it seems to supply the sensation of too much light.

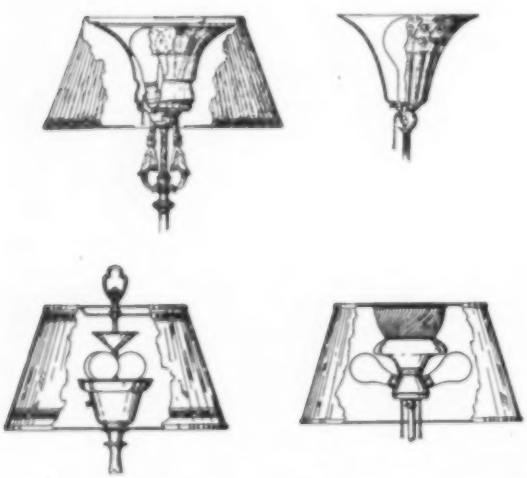


Figure 3. Progress in portable lamp design took a notable step forward in the early thirties, with the development of reflector elements. Later a dense diffusing glass was used for the reflector.

Figure 4. Current types of diffusers in portable luminaires.
A — (above left) — Blown glass diffusing bowls originally developed in 1933 for use with I.E.S. certified portable lamps. Used with 100-watt lamp in 8-inch size, 150-w or 50/150-w in 9¾-inch; and 100/300-w in 10-inch size.

B — (above right) — Type of glass diffusing bowls used in portable lamps which meet the specifications of the Certified Lamp Manufacturers.

C — (right) — R-40 lamp used in a wide harp.

Aside from this development, progress in lamp design was limited to deeper shades which shifted to parchment and paper. These often carried a tone of a brown antique on both the inside and outside. Since they were cone-shaped, they automatically provided an open top and some upward light began to appear.

In the early 1930's the indirect lighting torchere with a single 300-watt lamp appeared. Originally it seemed to be intended for storage in a closet with a folding card table. When the latter was brought out, the lamp also came out to assist the card players. Most of these were around 66 inches high and they were commonly finished in statuary bronze. Later the top reflector element was changed to a dense diffusing glass. However, they continued to be deep and narrow in form. These models were not stored in the closet but instead began to take their place in the home as an all-purpose lamp.

With the introduction of the 100/200/300-watt indirect light lamp in the G-30 bulb, shallower and wider bowl bases began to develop. These are still a standard item today, over 20 years later.

I.E.S. Study Lamp

In 1934 the Society's Committee on School Lighting completed the specifications for a table lamp intended primarily for use on study tables and desks. The basic model was one inch higher than a predecessor of 10 years before, mentioned above. Instead of using a 10-inch blass bowl and a 200-watt lamp, it used an 8-inch glass bowl and a 100-watt lamp. The diffusing bowl was placed higher in the shade than its prototype, thereby providing better shielding. The shade was 10 inches deep. It was tapered and had a 10-inch top diameter and a 17-inch bottom diameter. Its performance was measured in several ways. Dominant feature of its specifications was the illumination along the horizontal plane of the desk top upon which it was used. Shade brightnesses were held down to a low value and the shade linings were white. This was the first time a complete set of specifications for a table lamp had been written. Now Residential Lighting was being placed in a limited way on a quantitative basis.

Figure 5. Architectural lighting, with built-in techniques, was a feature of several "model homes" in the early thirties. The installation shown is the living room of such a home demonstrated in Minneapolis in 1932. Incandescent lamps were, of course, the light source.

As time went on, other specifications were developed by the Residential Lighting Committee for bridge, junior and senior floor lamps, as well as lamps for end tables at chairs and davenport. All of these specifications employed open glass bowls and the illumination performance was measured along a specified horizontal plane. The Illuminating Engineering Society cooperated in a Certified Program, so that lamps meeting its specification could be identified and offered as such to the purchaser. The I.E.S. Council withdrew its support of this certification in February 1944, essentially 10 years after its original launching. Over this 10-year period, millions of lamps carrying the I.E.S. tag of approval had been made and sold. The so-called "I.E.S. Lamp" had made a tremendous impact upon this phase of the consumer market. Commercially this program stopped July 1, 1945.

C.L.M. Lamp

Several portable lamp manufacturers, however, wished to carry on with performance and style quality lamps. This group organized a new program, sponsored under the name "The Certified Lamp Manufacturers." With a Technical Committee of their own and the assistance of a technical consultant, they began to develop a new program. A new set of specifications was developed in the early part of 1944.

A first industry showing of a C.L.M. lamp was made in November 1945 from specifications that were completed at the end of '44. Later specifications were completed for a full line of lamps including dressing table and dresser lamps. These specifications selected and defined the size and location of areas to which required values of illumination were to be delivered. Instead of the often unrelated horizontal plane, brightness was handled by reading candlepower or footcandles from the projected areas of the lamp instead of selecting brightness of limited areas. A manufacturer with a small test room could run all the necessary checks with no more equipment than a light-meter. In general, all of these lamps provide a greater proportion of downward light than did the previously made specification lamps. The average brightness of the inner diffuser had been increased to five candles per square inch, whereas the bowl of the early study lamp had a three candles per square inch limit.

The areas to be illuminated by various types of portable lamps as defined by the Society's recommended practice are in agreement with those contained in the C.L.M. specifications. Other parts of the C.L.M. specification are practical interpretations of the Society's work in the residential field. These include shade brightness, inner surface shade brightness, as well as the brightness of the inner diffuser when viewed from either above or below. A complete launching of the program at the retail level was made simultaneously throughout the country in September 1947. Lamps made according to these specifications may be identified by Certification Tags, which carry the initials C.L.M. Their standards of performance aim to supply the best at a practical commercial level. At the end of eight years, it may be noted that the commercial interest in lamps having good qualities of lighting varies in different parts of the country. Some cities show sustained interest, others do not. Cur-

rently there is little promotion of C.L.M. lamps locally and none nationally.

More recently the Edison Electric Institute launched specifications for portable lamps, which are tagged and identified as "Beauty-Plus Lamps." These were first shown at the 1954 Summer Lamp Shows, with 22 manufacturers participating. Later this number increased to 60. Beauty-Plus specifications include lamps with open bowl diffusers, C.L.M. lamps and lamps with wide harps for use with R-40 diffusing bulbs. Tags on these lamps differ from those used previously since they list and picture the type of lamp bulb to be used to get the best results. They also employ all the basic dimensions for shades for each type which in turn are similar to those included in the Society's recommended practices. Currently these lamps are being offered for sale in many parts of the country.

Lamp Bulbs and Tubes

As with other phases of lighting, progress and developments in residential lighting were in part due to developments in light sources over the years; partly to awakening awareness of the consumer as educational programs were launched.

At the beginning of the fifty-year period we are celebrating, the number of homes wired for electricity was about two million; all of the others could be considered as still using gas-light, kerosene or other flame sources. Even by 1910, only about 20 per cent of the homes in this country had been electrified, and in these the average lamps in service for light was about four per home. Up to this year, nearly all lamps in use were carbon filament, though by 1910, we can feel fairly certain that the new straight wire vacuum tungsten lamp was being used in some of the newer electrified homes. The 100-watt gas-filled lamp was introduced in 1915, though the literature shows no evidence that it was readily adopted for home use.

In 1919 a 50-watt white opal glass bulb was widely advertised as supplying "as much light as 100 matches," which gives some idea of the approach to home lighting, as well, even at that relatively late date. The daylight lamp had fairly wide appeal for home use at that time too, and flame tint lamps enjoyed a wide popularity. These were designed purposely to produce light having the same color as the candle and kerosene, which characteristic apparently had some nostalgic appeal. The demand from commercial users for a deeper and redder light increased the absorption and color so much that the lamp eventually lost its appeal to the homemaker.

A new complete standard line of *inside frosted* lamps was announced in February 1926. The new "A" bulb shape, tipless, with the frosting on the inside, was a part of this development. Many sizes of lamps were to be replaced by this new line, which included the following wattages: 25, 40, 50, 60, and 100-watt. In addition, there were two decorative lamps, the 15-watt, D-10 frosted and the 15-watt, A-17 inside frosted.

Intermediate based lamps, one with an S-11 bulb, 10-watt and the other with a T-6½ bulb (25-watt) were introduced for lighting ornaments, a reflection of some of the new ideas that were shown in the 1926 International Exhibition of Modern Decorative and Industrial Arts in Paris. These were later used in coves that could be made small enough to become a part of the wood trim above doors and

Figure 6. Model home demonstrated in Detroit in 1939. Fluorescent lamps in the soffit-cove were an innovation in home lighting.

Figure 7. Numerous techniques for residential lighting were demonstrated in this demonstration room (Horizon House) opened in 1946.

windows. Coves, as a lighting technique, were reported in 1931.

A dual-purpose lamp popular in the early thirties was the S-1 sunlamp which was frequently used in floor lamps decoratively designed, the unit intended to serve as a lighting device and as a source of therapeutic ultraviolet. The unit consisted of bronze base containing a transformer, a corresponding shaft topped by a large parchment shade, inside of which a large perforated oxidized aluminum reflector was used. The lamp itself was held in a base-up position.

Lamp bulbs especially designed for portable lamps appeared in the early part of 1930. The first to appear was 250-watt with an inside frosted G-30 bulb and medium base. It carried the name "Indirect-Light." This was followed in May 1934 by two three-light lamps with mogul three-light bases; one was the 100-200-300-watt and the other 50/100/150 watt. Later two lamps with three-light medium bases were added. These lamps used 50/100/150-watt and 30/70/100-watt filaments.

In the latter part of 1947 the R-40 reflector lamp bulb was offered for portable lamps as a self-contained unit needing no diffusing bowl. The first of these was offered with a white side coating and a frosted end. A dense white coating was applied instead of the regular aluminum coating characteristic of the reflector lamp used in commercial applications. A single 200-watt filament was used. The early part of 1948 saw the introduction of a similar lamp with a lighter density coating and a 150-watt filament. The brightness of that part of the bulb which supplied light directly to the reading page was between 10 and 15 candles per square inch.

After a year or so, this same lamp was offered with two filaments 50/100/150 watts since the demand for three-light operation called for this model. Today the demand is essentially for the three-light type.

The most recently announced lamp, October 1955, has two filaments and carries the name "High-Low." The two filaments are 30-watt and 200-watt respectively. Sockets are available for this lamp which turn on the two filaments simultaneously, switch on the low wattage filament next, and finally, off. Its service is intended especially for the larger table lamps and the smaller floor lamps.

Fluorescent lamps, both the straight and circular have made steady progress in the home since their introduction in 1938 and 1945 respectively, although the war years (1941-1945) were barren in developing lamps or fixtures. These years saw a great dearth of both lamps and fixtures for homes.

Studies beginning in 1946 showed that twelve per cent of the homes had installed fluorescent lamps to some extent. This percentage has increased each of the following years. The 1955 figure shows nearly 37 per cent. Fluorescent lamps in the home are found most frequently in kitchens, though their use elsewhere around the house is growing. Such installations average two and one-half lamps with the greatest number in the 15-, 20-, and 30-watt sizes. Fluorescent lamps including the 40-watt size are entering the home in ever increasing numbers today through the increasing interest in valance and cornice lighting. The improvement in color rendition supplied by the warm-and-cool white deluxe fluorescent lamps is removing earlier criticisms of fluorescent lighting for the home. The warm-white deluxe lamps are felt to be especially adapted to this use.

Another development in the incandescent lamp in 1948 met with wide acceptance in the home. This was the addition of a silica coating to the inside frosting of the 100-watt lamp. Its effect on the lighting performance of the lamp was some softening of shadows, and an apparent improvement in the quality of the light emitted, especially with some reading surfaces. More recently this coating has been added to all of the three-light lamps previously mentioned, including the newest "high-low" 30-200-230-watt lamp.

Somewhat related to the record of lamp bulb development in residential lighting, is the continuous effort throughout the years to do something about the almost universal practice of using unshaded bare lamp bulbs in the home. Especially

Figure 8. Techniques recommended for residential lighting in 1956 use light as a "tool" of decoration and for atmosphere and effect, as well as to provide functional lighting for specific areas according to the seeing task involved.

A — (right) — Dining cove also used as a study area. False ceiling installed 7 ft. 8 inches above the floor provides cavity for four 96T8 standard cool slimline fluorescent lamps, shielded by strips of corrugated vinyl plastic. Average illumination, 50 ft-c.

B — (below) — Three lens-type downlights using 250-w spotlamps are recessed in the ceiling of the second floor hall, so placed as to light the entire stairway.

C — (below right) — In modern bathroom, three rows of T-12 deluxe warm white slimline fluorescent lamps operating at 425 ma, alternate with four rows of 40-watt T-12 48-inch fluorescent sunlamps, each on separate circuits. Lamps are positioned 7 inches above egg-crate louvers of 3-inch cells to provide 45-degree shielding.

constructive efforts were made to meet this situation in 1923, when a number of the illuminating glassware manufacturers brought out shades that could be applied to bare lamp overhead fixtures. Later many so-called "adapter fixtures" were tried. None of these ever attained substantial success, with the possible exception of those designed around the use of the silver-bowl lamp. A further attempt to bring some improved form of lighting to this vast bare lamp market, was the development of a lamp bulb which attempted in its own design to alleviate the discomfort of unshielded bare lamps. First introduced in 1950, this lamp is shaped like a semi-indirect bowl, with the bowl section ivory enamelled. The neck of the bulb is frosted. Later it was also produced in a larger 100-watt size.

Another currently available source for use in portable lamps and home lighting fixtures has a pink coating. A wide variety of lamp sizes including some of the three-light types are supplied with this finish.

Home Lighting Education

A model apartment located in New York City appears to be the first substantial residential lighting demonstration display. It was lighted entirely by gas, and was reported in 1914. Illumination measurements on a horizontal plane 30 inches high were reported to show 2.5 and 1.5 footcandles at the center of the library and dining rooms, respectively. The kitchen value was nearly seven footcandles. The locations measured seem naive to us, today. They have almost no relationship to the areas in a room where visual tasks are performed! To give these early investigators their due, however, it might be noted that this indifference to the locations at which light was really needed, existed to some extent into the 1940's, although some teaching and sales programs began using a light meter in the living room in 1932.

In 1919 an outstanding lighting demonstration living-room was completed in Cleveland. It employed colored lamps, filament lamps and daylight lamps. With this installation, atmosphere, creation of "moods" and various lighting effects were demonstrated.

The housewife and her family participated nationwide in one outstanding home lighting program in 1924. This was an extremely successful campaign to raise illumination levels in the home kitchen. A white glass enclosing globe with close ceiling fitter, using either a 100-watt clear lamp or 150-watt daylight lamp was offered, usually through the local utility and sometimes at easy-to-pay terms added to the light bill. Hundreds of thousands of these units were installed in kitchens throughout the country. This taste of better light in the home, insignificant as it may seem now, did much to interest the consumer in the subject of home lighting. The increasing lay interest in residential lighting in the twenties might be reflected in the publication of one of the first complete books on the subject: "Lighting the Home" by M. Luckiesh.

Demonstration rooms were included as part of a formal school of lighting in 1923, the first of a rash of such exhibits for the public's education during the 1920's. One such exhibit in Cleveland in 1923 was co-sponsored by the Illuminating Engineering Society and the Illuminating Glassware Guild, and shown at a Better Home Exposition in the Cleveland Public Auditorium. It was during this period, in 1925, that the first formal Home Lighting Training Conference was established, in Cleveland, Ohio; the first in a continuous annual schedule which has been uninterrupted for 30 years. Currently, numerous "courses in home lighting" are given in many parts of the country, several sponsored by I.E.S., but in those days the training of personnel was a serious need. Indeed, it still is.

Two major Lighting Institutes launched in 1929 in New York and 1930 in Chicago were contributing substantially to this phase of education. The residential lighting demonstration areas in each of these were significantly outstanding. The Chicago Lighting Institute is operating still, with a full schedule of home lighting conferences, in addition to its well-known clinics on other phases of illumination.

A Home Lighting Essay Contest, conducted nationally in 1924, added much to the growing awareness of lighting in the home. Over 4700 towns participated in this program. A complete home was the first prize; and scholarships in colleges were included in the prize list.

The Eyesight Conservation Council of America brought out a most significant bulletin in 1925. Its title "Eyesight Conservation Survey—Bulletin No. 7" brought together all the statistics and experiences on the subject in a most useful, and even amazing way.

How to reach the home-maker with the message of proper lighting, however, had been puzzling many people for some years. One outstanding endeavor to do this was a well-considered door to door series of calls made during March of 1933, right in the middle of the Depression and under the most desperate national financial circumstances. Utica, New York was the locale of this experimental program. A demonstration kit was developed for the purpose, and the demonstration call was made directly in the home, calling from door to door. At the end of the trial period, the effectiveness of this type of personal education was clearly apparent. The program was an outstanding success. From this experience and others, a national activity along these lines was launched. A complete training course for both home lighting advisors and supervisors was developed and published. From a few hundred people, the number of people working full time on residence lighting grew to 1000 very quickly with this program, and a few years later was approximately 2500.

This vast corps of residence lighting people soon allied themselves and their work to that of the Illuminating Engineering Society. Residence Lighting Forums, subsidiary branches of I.E.S. Sections, were established in the fall of 1937 in the Chicago, Cleveland, New York and Philadelphia Sections. They conducted their own programs, all related to residence lighting, elected their own officers, established separate dues, and had, in addition to regular I.E.S. members, a great number of "affiliate

members," people whose sole interest was home lighting. Currently there are active Residence Lighting Forums in the New York, Philadelphia, Chicago, Georgia, Tennessee Valley, Ohio Valley, Utah, Michigan and St. Louis Sections of I.E.S., most of them conducting some eight meetings a year, many of them also conducting full-fledged courses in residential lighting for interior decorators and others.

Interest of other related groups, as well, was apparently stimulated by the activity in residence lighting, during the thirties. In June of 1937, one of the leading magazines of interior decorating *(Interior Design and Decoration)* sponsored the first National Lighting Conference. The program occupied two half days, fitting into the American Institute of Decorators' National Conference, which ran concurrently. Homes at both the 1933 Chicago World's Fair and the New York World's Fair Homes of Tomorrow were well handled from both the fixture and portable lamp standpoint, and thousands of people were exposed to good design in residential lighting. Built-in lighting was also a feature of these model houses.

Architectural lighting, or built-in techniques, had appeared prior to these Fairs, however. In 1931 extended panels of opal glass were incorporated in the soffit over the sink in four newly designed all-electric planned kitchens. In the early thirties, the first installations of valance lighting over windows appeared. Lumiline incandescent lamps were used with them. In 1937 the lighting design of a complete modern house is presented with corresponding studies of the brightness, brightness ratios, and footcandles throughout. This house made extensive use of valance lighting. Today the extended lengths of valances, cornices, and wall-brackets using fluorescent lamps are coming into use in many classes of homes.

During 1931 a series of Conferences covering all phases of home building and home ownership were held in Washington, D. C. A separate committee on fundamental equipment included lighting and wiring. At the end of the year, a four-day meeting of all committees was called by President Herbert Hoover. This final conference was called "The President's Conference on Home Building and Home Ownership." A twenty-eight page report covered recommended practices for both wiring and lighting the home. Lighting fixture allowances for small homes at the time averaged 1.5 per cent of the cost of the structure.

In 1932 an excellent report from St. Paul and Minneapolis presented a series of rooms in which built-in lighting was used extensively in the living-room, dining room, bedroom, bath and kitchen, as well as in a reception hall. At the same time some very fine work was being done in France, England and Germany. Most of these techniques were, of course, far ahead of general practice.

Over the years, a growing literature on how-to-light-your-home contributed substantially to improved practice. The Society's own Residence Lighting Committee participated in this, preparing in 1932 the I.E.S.-sponsored book "Artificial Light and Its Application in the Home." In June 1945 the Society also published the first "Recommended Practice of Home Lighting," an officially approved standard for the lighting of homes, and in 1953 published a completely revised "Recommended Practice." The widely-distributed booklet "Contemporary Lighting for Modern and Traditional Interiors" was published by I.E.S. in 1951. In addition, many millions of booklets on good lighting practice have found their way into the home, distributed by trade organizations and firms within the lighting industry.

A number of good books on residence lighting are also available for the guidance of interior decorators, homemakers and others. Two of these books, prepared specifically by lighting specialists, reflect current practice: *Residential Lighting* by Myrtle Fahsbender, published in 1947, and *How to Decorate and Light Your Home* by E. W. Commery and C. E. Stephenson, published in 1955. This presentation is the first to closely integrate lighting and interior decoration.

The public taste for good lighting in the home has been stimulated in recent years through many other mediums, as well. Nineteen forty-six saw a new type of residential lighting demonstration in "Horizon House" at the Lighting Institute of General Electric in Cleveland, Ohio. Here, for the first time to such an extent, interior decoration and advanced lighting techniques were coordinated into the structure of the room. Currently this same Institute has opened a new residential lighting teaching and training center.

In 1952, the first full length motion picture demonstrating home lighting techniques, with sound and color, was released. Its title "Bright Future" is indicative of its story. Currently, black and white prints are being shown on television. This, and other motion pictures, such as "Better than Kings," have influenced a wider audience than anything previously produced.

Summing up, it has always been evident that the channels of information distribution to the family are wholly inadequate. This appears to be still true, although vigorous steps are being taken to overcome the great lag between lighting practice developments and their use in people's homes.

PUBLIC BUILDINGS

At the time the Illuminating Engineering Society was born, there was no real planned lighting in public buildings. The newness of electric lighting and the lack of experience in its application resulted in the simplest kind of illumination design. A prominent technique of the day was the use of hundreds of low lumen lamps to outline interior architectural features.

As simple as it was, this early technique introduced in public buildings — buildings more or less monumental in character — the first real coordination between lighting and the architectural theme. Even today, this coordination is found more often in public buildings than in other structures. In approaching the problem of applying the newly developed electric lamp to the illumination of interiors, architects adapted the design of metal ornaments to chandeliers and wall sconces. Metal craftsmen, happy to find a new outlet for their talent, turned these adaptations into the first "ornamental" luminaires.

For many years, such fixtures were used almost exclusively in public buildings. As late as the 1920's, there were hundreds of firms in America profitably employed in making iron, bronze, or crystal chandeliers designed to blend in with the architectural style of the time.

About this same time, Augustus Curtis pioneered the development of techniques and equipment for the indirect lighting of interiors — a substantial contribution to the art of illumination. This gave rise to a period during which ceilings and walls were lighted by lamps and reflectors completely concealed in fixtures or architectural elements.

Popular from the time of their introduction until the present, neither ornamental nor indirect lighting was suited to intensities of illumination much above five footcandles in the large areas in-

About 1920, the practice of lighting churches with two rows of lanterns came into vogue; today, in 1956, lanterns are still used extensively — particularly in conjunction with downlighting or indirect lighting. Church of Our Lady of the Blessed Sacrament, Harrisburg, Pa.

This lobby was typical in the Twenties when the motion picture theatre was the "Poor Man's Palace." Mastbaum Theatre, Philadelphia. Photos of pre-Twenties installations are both poor and hard to come by. Illumination levels were too low for photographic methods.

1906—Ornate edifices—uncoordinated with visual needs

1956—Structural design—teamed with the lighting art

volved in the lighting of public buildings. As the demand for more and more light became persistent, new application techniques were imperative. Coming in the late twenties, this demand for more light coincided with the stock market crash and the subsequent depression. Thus it arrived hand in hand with pressure for greater economy.

About this time, the technique of downlighting was introduced. By distributing the light directly down onto the working plane, hidden or inconspicuous luminaires were able to provide a high degree of utilization resulting in levels of illumination heretofore not attempted. From this time until the present, ornamental luminaires, indirect lighting, and downlighting have been effectively used — singly or in combination — in most public buildings.

Today the variety of modern light generating and control equipment gives these techniques greater scope and effectiveness than ever before. Add to them only the large area source, such as louverall or luminous panels, and you have the basic tools used in modern public building lighting.

The lighting of such public buildings as churches, auditoriums, theaters, banks, and museums, have much in common, but because of their different functions, some of the application details differ. During the years at the turn of the century, differences in detail between these applications were small, but as new sources and more specialized lighting equipment became available, the lighting for each of the various types of public buildings became more and more specific.

Churches

Churches might be considered the most important of all public buildings. Certainly, they have been the most influential on architectural style. It is significant that their contributions have been primarily artistic. Through the history of the church, painters, sculptors, and stained glass craftsmen have labored to create interiors of inspirational beauty. At the start, an important part of this effect was created by the careful control, by building designers, of what little natural light was permitted to fall inside the structure. From this tradition, artificial lighting inherited its present importance as a medium of artistic value in the design of church interiors.

With the advent of the scientific age, there has been a tendency to discount the artistic approach. Modern contributions to the church — heating, air conditioning, acoustical control, and public address systems for example — all augment the physical plant without improving the artistic effect of the interior. Lighting, alone, can claim to have both physical and artistic attributes.

As in other public buildings, early electric lighting in churches either studded the interior with bare bulbs or made use of chandeliers of a traditional type in which electric candles were substituted for real ones. With the availability of higher wattage lamps, indirect lighting moved into the church. The first church lantern made its appearance about 1920.

Lantern lighting gradually became accepted

Installation during the Thirties had skylight for daylight and floodlighting. Continuous troughs over quotation boards had prismatic lenses. San Francisco Stock Exchange.

When the original skylighting was no longer considered adequate, pendent downlight fixtures were added to improve the lighting, if not the general effect. Harvard School of Business Administration, Cambridge, Mass.

Indirect light of about 38 footcandles, plus recessed ceiling lights to illuminate upper walls, creates one of the outstanding installations of the World War II era. Downlights are equipped with prismatic lenses. Senate Chamber, National Capitol, Washington, D. C.

practice and soon reached a position of dominance unchallenged until very recently. With today's demand for higher levels of light in churches, the lantern is being replaced or supplemented by recessed downlighting.

Many modern church lighting installations consist of two separate systems: (1) indirect lighting or the use of ornamental luminaires to fill the artistic and emotional need, and (2) direct downlighting over the pews to provide light for the reading of hymnals or missals. In some churches the varying importance of the elements to be lighted — the pulpit, the interior architecture, the choir, and the pews — is given special consideration with the installation of selective switching and dimming equipment. With such equipment, the lighting is frequently programmed to create a setting of maximum effectiveness for each portion of the service. With its ability to set mood and concentrate the attention of the congregation, such a lighting program can be a profound influence on the effectiveess of a religious service.

Auditoriums

School and college auditoriums built during the last 50 years have been intended primarily for assembly, chapel, lectures, concerts, and plays — uses which called for just enough general illumination to permit the reading of programs. As a result, neither the Illuminating Engineering Society, nor the lighting industry, paid much attention to the subject. For a number of years, auditorium lighting consisted of a few ornamental fixtures carrying bare lamps.

This point of view changed sharply during the second world war. Schools and colleges across the country were short of classrooms and in many instances the auditoriums were drafted into duty as study halls. For this use, the old ornamental lighting was clearly inadequate. Since that time, architects and school authorities have been alert to the need for more flexibility and higher footcandle levels in lighting auditoriums.

The inadequate auditorium lighting of the past was largely a matter of economics. Lighting equipment for large rooms was expensive to install and

operate. Furthermore, most large auditoriums were used only a small part of the time, a persuasive argument against heavy investment in lighting equipment.

Today, with the emphasis on maximum utility of auditoriums, much consideration is given to the flexibility and adequacy of the mechanical and electrical plans, with emphasis on acoustics, public address systems, air conditioning, and lighting.

Many early auditoriums were lighted in the daytime through skylights, and it was not long before the night-time floodlighting of these skylights from the attic became a popular method of lighting the room. From this evolved various systems of downlighting designed to illuminate the seating area at moderate cost.

Theaters

Similar to auditoriums in many ways, theaters have a history of their own in the matter of lighting. The many changes which have taken place in theater lighting practice during the last 50 years have not all been the result of lighting evolution. Theater operation, itself, has changed a great deal since the time of the founding of I.E.S.

In those days, the intermission was almost as important as the performance and promenading in the foyer, to see and be seen, was an important social function. Little remains of this practice beyond the traditional stretch and smoke between acts in the legitimate theater. Here, where the auditorium is lighted during intermissions, the use of elaborate ornamental chandeliers and wall brackets has been accepted practice.

With the advent of continuous performance cinema, there was no longer any justification for decorative lighting equipment. Instead, low intensity cove lighting came into use to provide decorative effects and a low ambient illumination during the showing of the film. Simple recessed down-

The mid-century architect likes dramatic effects and often uses light to produce them. Park Synagogue, Cleveland.

The combination of diffuse general lighting with spot lighting and directional fluorescent light gives excellent results, but a somewhat restless ceiling.

Specific lighting elements for each specific purpose contribute to a well-organized room.

lights were used to light the seating area before and after the show.

Banks

In the days of the first electric lighting, bank design was in an era of monumental buildings and deliberate opulence. Banks seemed to be trying to outdo each other in erecting impressive structures, possibly on the theory that investors would accept this magnificence as evidence of stability and soundness. Large bronze chandeliers, studded with many small bulbs, were a part of the generally impressive atmosphere. Understandably, these fixtures were never very successful as lighting units and each desk and table required its own portable lamp. In addition, strip lighting was mounted on the anti-robbery screens separating the customers from the tellers to provide working illumination for the daily transactions.

In present-day bank design, modern protective devices make the elaborate screens unnecessary and customer and teller now do business across a relatively unobstructed counter. With no handy mounting place for the counter lighting, the working light had to be provided by the general lighting system or by recessed downlights located in the ceiling over the tellers cage. Areas on the private side of the counter are lighted with conventional office type luminaires or by modern ornamental fixtures, depending upon the degree of separation from the public lobby area.

With the disadvantages of their initial cost, heat loss, condensation, and cleaning cost, the once popular skylight has not survived in banks. However, the decorative indirect fixtures which replaced the skylight are now giving way to its close relative, the large area luminous plastic panel. In one of the most recent bank designs, the glass-walled Manufacturers Trust Company in New York City, the ceilings are completely luminous.

Museums

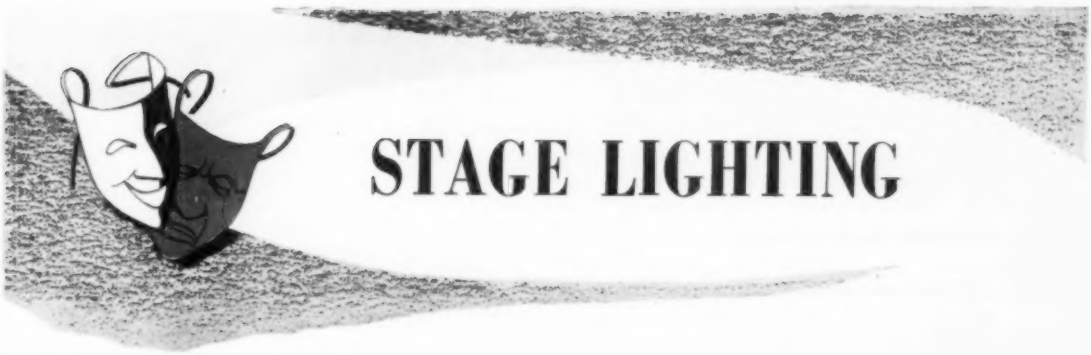
Existing museums were designed and built for use in daylight only. Exhibits were placed to take maximum advantage of large windows or skylights. Only recently has high quality artificial lighting been attempted. The National Galleries in Washington, the Metropolitan Museum in New York, and the work of French lighting engineers in the Louvre, represent the progress being made today in this field.

In museums and more particularly in art galleries, the illumination on vertical surfaces is more important than that on horizontal surfaces. Then, too, since faithful rendition is essential, and since most displays and paintings are intended to be viewed under natural daylight, any artificial illumination used must be of carefully planned spectral composition and must be incident from a direction which will create a natural setting.

Summary

To summarize, the lighting of public buildings has grown in stature and complexity from the use of bare incandescent lamps to outline interior architectural features to the combined application of ornamental luminaires, indirect lighting, and downlighting. The fluorescent lamp and rapid strides in the development of transparent and translucent plastics of high stability have combined to add the large area luminous source to these tools of modern public building lighting.

Still the leader in the architectural integration of illumination, the lighting of public buildings contributes substantially to the advancement of general lighting practice.



STAGE LIGHTING

Lighting in the theatre at the turn of the century saw the trend toward gradual elimination of acetylene, gas and electric arc sources. The rising new star in theatre lighting was the wonderful new electric lamp.

As might be expected, each theatre changeover to electric lamps was presented to the public as a great step in progress. Playing this theme with marked effectiveness a few theatres went all out in terms of the number of lamps installed. This was a dramatic yardstick that the public readily appreciated. A few spectacular theatre installations were advertised as having thousands of the electric lamps.

It has been argued that the adoption of the electric lamp by the theatre had considerable hastening effect upon its adoption for more general purposes. It is impossible to escape the fact that following the practical development of the incandescent lamp by 1879, within three years, by 1882, the following theatres had at least a partial installation of the new light source: the Paris Opera, the Savoy in England, the Brunn Theatre in Austria, the People's Theatre in New York, the Halstead Street Academy of Music in Chicago, the Bijou in Boston, and the Baldwin in San Francisco. In the same year a small theatre was erected at the Munich Electrotechnical Exposition and this theatre employed the new electric lighting exclusively. The exhibit attracted world-wide attention and may have hastened the adoption of incandescent lamps for general purposes as well as theatre lighting.

The first electric lamps were not developed, of course, especially for theatre use. It may be stated, however, that a good many subsequent developments have been due to the special demands of the theatre lighting industry. Interestingly enough, sooner or later a number of these developments have been carried to other potentials in non-theatrical lighting equipments. The prefocus base lamp, the monoplane and bi-plane filaments, and the burn base up tubular lamp are a few examples of equipment developed as the result of requests by the theatre equipment industry.

Just as in the case of the new electric lamp, manufacturers of theatrical equipment often have led the lighting industry in introducing new developments. This is probably because theatre itself is essentially experimental in nature and equipment manufacturers have learned plunge headlong into the mysteries of developmental operations. Thus, there is present widespread use in the lighting industry of the ellipsoidal reflector, the Fresnel and step lenses, pin-hole downlights, picture lighting projectors, striplights for drapery lighting, ceiling coves, and architectural exteriors. Similarly, spotlights for highlighting merchandise in stores or display windows are essentially theatrical lighting equipments and the treatments are essentially dramatic in nature.

The fluorescent lamp was introduced to the general public at the New York World's Fair in the late thirties . . . installed in equipment furnished by theatre lighting equipment manufacturers. The first commercial applications of the recently developed fluorescent dimming systems have been by the same manufacturers. Other intensity control devices, perfected for theatre application, have only later been transferred to the realm of architectural lighting.

All of the available evidence indicates that the trend setting lighting applications in fields where the aesthetic result is important have tended to use theatrical equipment or related equipment by theatrical manufacturers.

Theatre lighting is a relatively small segment of the total lighting industry. Paradoxically, however, theatre lighting with the allied expressions in motion pictures, television, and display, has made the dramatic and artistic use of light more evident and full of promise. It may be too much of an

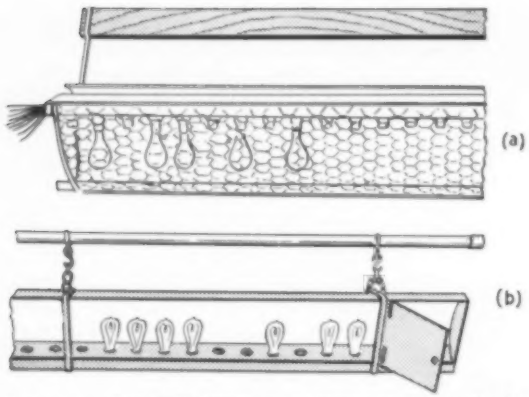


Figure 1. Borderlightings of about the turn of the century. The combination gas and electric borderlight (a) is complete with gas jets at the bottom and electric lamp sockets at the top. The wire screening and wooden drapery guard are to help prevent igniting the stage and its occupants. Because of fire danger and relative inefficiency, it was soon replaced by the completely electric borderlight wired for 16- or 32-cp lamps (b).

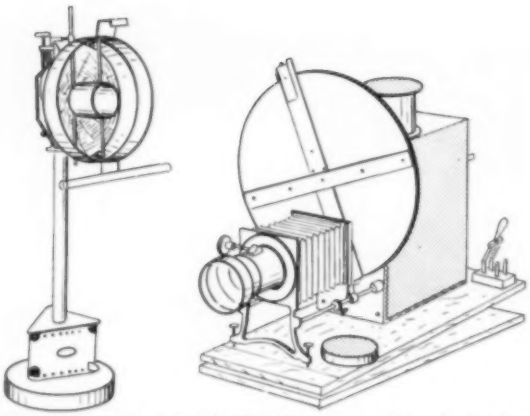


Figure 2. (left) Gallery Reflector — modern in its day (about 1905). The parabolic shaped reflector was heavily nickel-plated. With its inside tubular light-control sleeve, it is a forerunner of present parabolic reflector floodlights.

Figure 3. (right) Stereopticon used in combination with moving effect discs on which clouds, rain, snow, water ripples etc., were hand-painted on mica plates. In the early 1900's, the drama critics never failed to mention the latest effects.

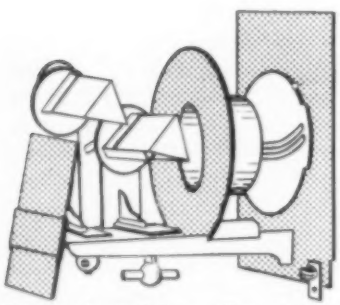


Figure 4. Rainbow effect attachment for Sciopticon. This particular attachment was standard for Metropolitan Opera productions of "Rheingold," in the early years of I.E.S.

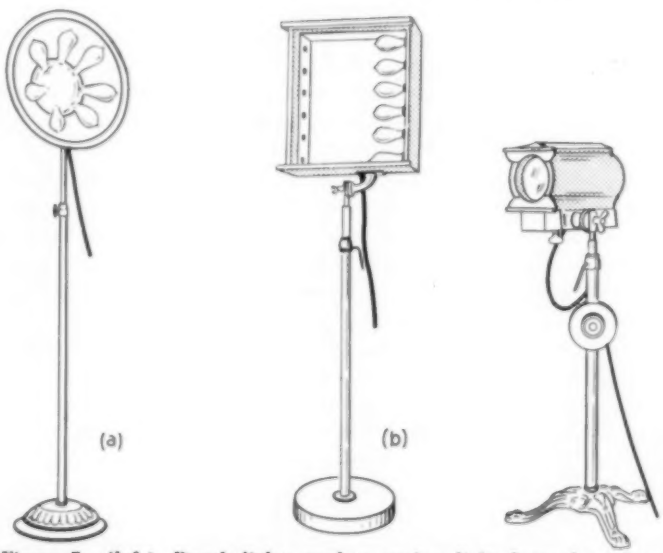


Figure 5. (left) Bunch lights used to project light from the sides of the stage onto the scene. The round head bunch light (a) was made of reflector tin; the square head unit (b) was of galvanized iron painted white and provided with grooves for silk or gelatin color media.

Figure 6. (right) Baby spot light, long ago. With its Russian iron hood, 5-inch diameter plano-convex lens, and 100-cp Edison base Stereopticon Lamp, it gave a "mild ray of light" which had the advantage that "the light will not flicker." It appeared first in catalogs of 1906.

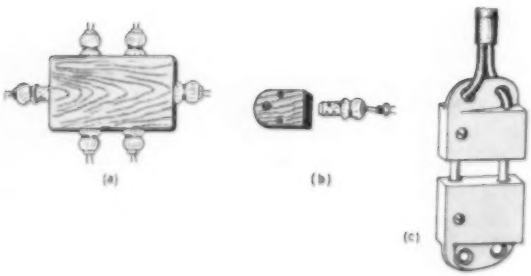


Figure 7. (left) Early spider pockets and connectors, circa 1900-1905. The spider pocket (a) was of hardwood; of the six plugs one was a feeder and the remander the distributors. A single pocket and plug (b) shows an early stage in the development of the "stage plug" still in common use. The last drawing (c) is an early model of the split pin plug connector. Of hard fiber and nearly indestructible, later plugs of this type are still standard for stage installation.

exaggeration, except to make the point clear, but the stage uses light more extensively and more freely than any other field. It shows what light can mean to an audience, the public, more than other fields of application. While the dramatic effect becomes the primary objective, all of the engineering that can help produce this effect is considered. With costs soaring, the artist more and more has been called upon to justify inspiration in terms of good practice as well as in terms of good effect. The engineer and the artist are getting together and more and more their objectives are occurring in the same person.

Literature and Early Development

A quick glance at a list of articles published by the I.E.S. over the past fifty years would show that stage lighting has made its way into print in I.E.S. publications infrequently. But, as a matter of fact there are several score of volumes devoted to this specialized field and a complete bibliography of worthwhile articles on theatre lighting would include well over a thousand items. This is a considerable amount of printer's ink for a field where, notoriously, everyone has plenty of time to talk but is too busy to write.

Those papers which have appeared in I.E.S. literature have tended to formalize, and excellently, the best of the current practice of the time. Many of these articles have not only expressed the engineering concerns, but have also tended to be inspirational in subject matter. From such materials, from catalog collections, and from recollections of the time we can review the development of stage lighting over the past half century.

In the first years of the 1900's the settings on the American stage were in the main of the "wing and border" type, *i.e.* of the same general form and appearance as might be used in production of the classic ballets today. But instead of imaginative designs the settings were presented as realistically as possible through the use of painted perspective and painted chiaroscuro. The actor moved in a light which illuminated the setting and himself equally badly, the lighting calculated to bring out the best of the scene painted as much as anything else.

A major element in the lighting equipment was the borderlights, directing light on the actor and setting from above. The borderlights were sometimes fitted for combinations of gas and electric lamps or either one separately. From below, the actor was lighted by footlights, frequently gas, frequently electric, sometimes the combination. To these two major sources of illumination were added "ollivette" or open-box arc lamps directed upon the stage from the wings. These together with arc type lights placed in the balcony and known as "gallery reflectors" (they used parabolic shaped reflectors of nickel) were the major sources of illumination. Other units available and in more and more frequent use as the years went on were all kinds of visual effect machines including sciopticons, stereopticons and effect slides and discs. All of these devices were intended to enhance the realism of the stage picture.

Incandescent bunch lights ("dishpan" shaped reflectors in front of which were mounted a dozen or so 16 cp 50-watt lamps) were available. There were, of course, the ballast rheostats for the arc lights, and also the "Iron-Clad" resistance dimmers in many sizes for dimming 10-25 and up to 120-300 of the 16 cp lamps. Both interlocking dimmer banks and individual plates were available. Stage floor and wall pockets of cast-iron, slate lined, were in use, with the body of the stage plug of hardwood. Color mediums consisted of gelatin sheets and hand-painted colored silk rolls for the arc lights, and lamp dips for the incandescent lamps.

In 1906 when the Illuminating Engineering Society was founded the gas and electric combination striplight was gradually giving way to the solely electric striplight. Portable light sources were generally of the arc type, although within a few short years as the larger incandescent lamps demanded by the industry were made available they were quickly utilized in the portable equipments. A manufacturer's catalog of 1906 introduced a 100 cp Stereopticon lamp "baby spot light" with the words "No skilled electrician is required to operate it. The light will not flicker." Within three years the combination gas and electric striplight had been dropped from the catalogs, and by 1913 the first of the disappearing type footlights had been patented and catalogued.

Considerable fun has been made of these early instruments and the lighting of the period is frequently derided. Nevertheless some surprisingly excellent examples of stage lighting may be recalled. There was Louis Hartmann's lighting for Belasco of "Madam Butterfly" (1900). Its beautifully executed and very subtle five-minute fade from sunset to sunrise was a prime example at the beginning of the century of the dramatic, psychological and evocational potentials of lighting. In 1905 for "The Girl of the Golden West" Hartmann used a backlighted translucent front curtain for the opening fade-in. For "Rose of the Rancho" (1906), there was no dialogue in the opening six minutes of the play while the incandescent "lens-

Figure 8. A touching scene from the "Round-Up," presented in 1910. This illustrates the flat lighting typical of many early stage productions. Lighting is chiefly from border lights, although since the photograph was probably taken with flash powder, it does not strictly represent the actual lighting effect.

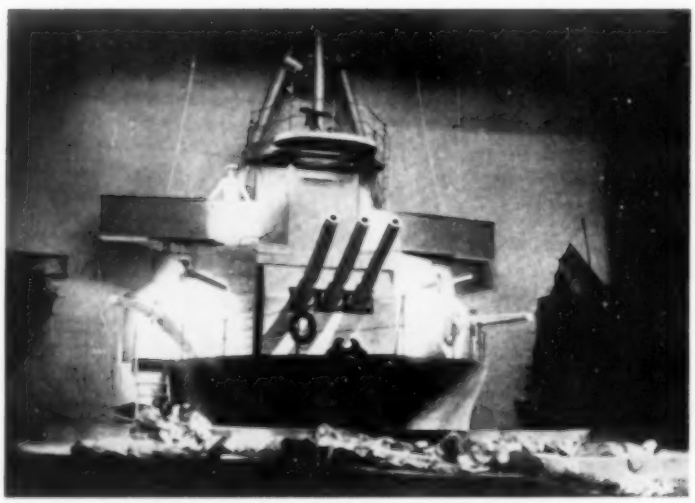


Figure 9. In contrast to Fig. 8, note the dramatic effects obtained with lighting in this battleship scene from "Roar China" done by the Theatre Guild in 1930. The setting and lighting were designed by Lee Simonson and the photograph is by Vandamm. This shows the use of directional light so typical of the more recent lighting techniques, chiefly from spotlights.

Figure 10. For "Madam Butterfly" in 1900, the lighting designer Louis Hartmann arranged a series of lights behind the translucent screens. Each light was equipped with a silkcolor roll and as the rolls were turned the effect on the screens faded from sunset to night and to sunrise. (Courtesy New York Public Library — Theatre Collection.)

Figure 11. A dramatic scene from "Girl of the Golden West" (1905) shows the surprisingly effective and dimensional lighting sometimes achieved in that early period. Miss Blanche Bates was starred. (Courtesy New York Public Library — Theatre Collection.)

hoods" were dimmed in to literally paint the set in a western sunrise. By 1911 with "The Return of Peter Grimm" Hartmann was using an incandescent follow spotlight to give his lead character an ethereal look.

Another great practitioner of the period was Joseph Urban. By 1914, in productions at the Boston and Metropolitan Opera Houses, he had shown the kind of dramatic collaboration attainable between stage setting, actor, and stage lighting. "Pelleas et Melisande," "Tristan and Isolde," "Monna Vanna" and others of Urban's work show this collaboration.

For the production of "Chanticlere" (1911), an architect named J. Monroe Hewlett was helped by a member of the I.E.S., Bassett Jones, in working out a remarkable scrim-translucency effect. (Jones was later to be Illumination Consultant to the New York World's Fair of the late thirties.) But it was a rare occasion in those days when special engineering talent was called upon to achieve dramatic effects in lighting. As a matter of fact the high caliber of the work done with the then existing equipment shows the relatively high state of development of that equipment in the first few years of the century.

Progress: World War I to World War II

The practice of theatre lighting developed at an accelerated pace between World War I and World War II. Not only was there further development of specialized equipments and the introduction of new procedures, techniques, and artistry, but of equal importance, the first real formalization of stage lighting techniques.

That progress was accelerated stemmed primarily from a great new theatre movement which sprang up just before World War I, and then prospered actively throughout the twenties. As part of this movement the creative artist was

Figure 12. Maude Adams starred in "Chanticlere" (1911) for which the scrim-translucency effect shown here was used for the first time to gain a remarkable effect of depth. J. Monroe Hewett and Bassett Jones (an early I.E.S. member) have been credited with the development. (Courtesy New York Public Library — Theatre Collection.)

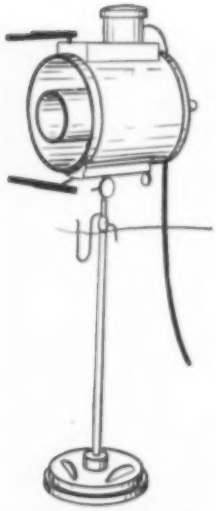


Figure 13. (left) Nitrogen Olivette or Open-Box Floodlight introduced about 1913 to replace the electric-arc floodlight and the incandescent bunch light. The unit shown used a 1000-watt PS 52 lamp.

Figure 14. (right) Long-throw parabolic reflector floodlight developed for the production of "Caliban" (1916) at the Stadium of the College of the City of New York. The reflector was adjustable which permitted focusing for a narrow or a broad beam of light.

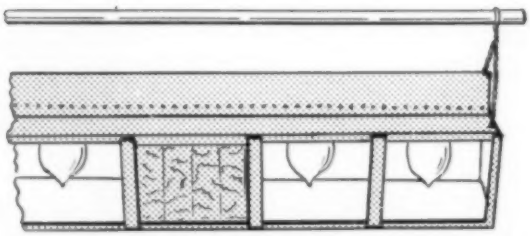
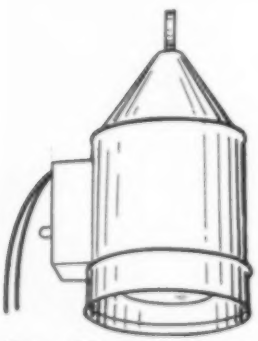


Figure 15. The compartmented borderlight, circa 1918, with slide grooves for gelatin color media, was first introduced for 500-watt lamps. Within a short period of time very carefully designed mirrored glass reflectors were introduced into the sheet metal partitions. Present-day striplights use Alzak process reflectors but retain much of the same basic construction shown here.



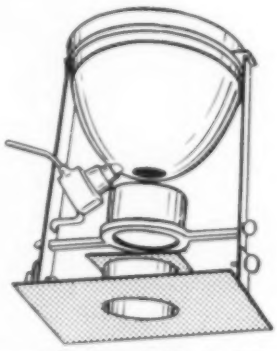


Figure 16. (left) Suspension type spotlight available in 500-, 1000- and 1500-watt sizes by 1918. These were used overhead between borders and enabled very bright down lighting.

Figure 17. (right) The ellipsoidal reflector downlight used in the Center Theatre (1932) had a 250- or 400-watt G-type lamp. The ceiling opening measured 4 inches. This became the forerunner of ellipsoidal reflector spotlights and auditorium downlights.

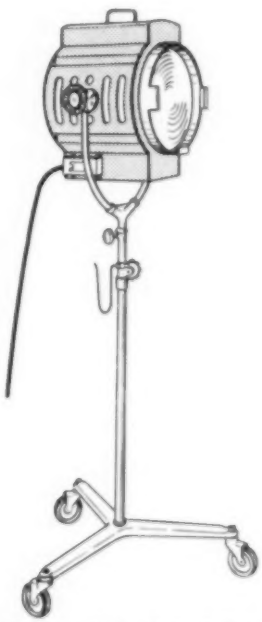


Figure 18. One of the first of the true Fresnel lens spotlights introduced in the late 1920's and early 1930's. There was a complete wattage range available by 1936, 250-5000 watts.

brought more and more into the theatre as a revulsion against the realistic conventions of the earlier years of the century. This artist was concerned with what may be called the concept of "total design" over the entire visual stage picture. The early philosophers of this movement, called "the New Stagecraft," included the Swiss, Adolphe Appia, and the English, Gordon Craig. In this country the Little Theatre groups such as those founded in 1912 by Winthrop Ames, Livingston Pratt, Maurice Brown, and Samuel J. Hume advanced the work. In future years those groups and others like them such as the Provincetown Players, the Washington Square Players, and the Neighborhood Playhouse (all founded in 1915) were to have a tremendous effect upon the American Theatre.

The Provincetown gave Robert Edmond Jones his first opportunity for design. His later works

including "Til' Eulenspiegel" (1916) for Nijinsky, "Richard III" (1920), "Macbeth" (1921), and "Hamlet," (1923), are essentially stage settings of light . . . conceived, born, and displayed to the audience through the dramatic medium of light. From the Washington Square Players came Lee Simonson, who as designer for the Theatre Guild conceived the settings for "Lilliom" (1921) with its famous railroad trestle scene, "Back to Methuselah" (1922) with the first important use of projected settings in this country, "Man and the Masses" (1924), and "Dynamo" (1929), among others.

Among other names to be remembered for their lighting work in this period are Norman Bel Geddes with "The Miracle" (1924) which converted the Century Theatre in New York to a Gothic Cathedral and set a new high with a wedding of production elements achieved through lighting; Claude Bragdon with his production designs for Shakespearean tragedy commencing in 1925; Henry Dreyfuss designs for "The Last Mile" (1929). Cleon Throckmorton, Hazard Short, Albert Johnson, Jo Mielziner, and Donald Oenslager, were all doing their first professional work in this same period. Thomas Wilfred became interested in lighting as an artistic expression in itself and developed a series of projection machines for the achievement of a silent symphony of light. Monroe Pevear, an architect and engineer, became interested in George Pierce Baker's 47 Workshop at Harvard, and from this interest went on to the development of a line of theatre spotlights and color specialty items.

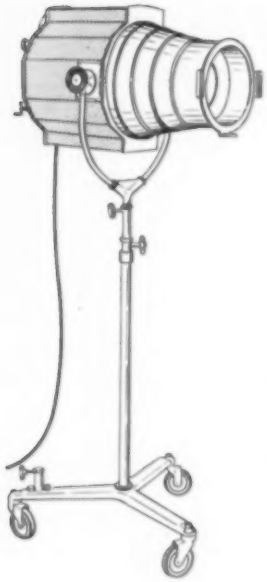
The actual formalization of theatre lighting techniques commenced roughly in 1925 with the creation of a graduate Department of Drama at Yale University. Graduate work in lighting at Yale was followed within a few years by similar coursework at such institutions as the University of Iowa, Northwestern University, Carnegie Institute of Technology, etc. There has been steady growth in the teaching field since today perhaps 40 institutions have graduate level instruction and well over 200 have undergraduate level instruction in stage lighting coursework. The teaching of lighting has had considerable influence upon the development of the art as practiced and upon the development of equipment. The formalization of instruction has led to analysis and thorough study of lighting problems. Many of the college-trained students have gone into theatre production work or into association with the lighting equipment manufacturers.

The development of equipment throughout this period considerably advanced and facilitated the practice of stage lighting. Progress in light sources had by 1913 cleared the way for the introduction of the 500- and 1000-watt Nitrogen Open-Box Floodlights. These soon were replacing the electric arc floodlight. Nitrogen Sciopticons were introduced and by 1918 the parabolic reflector floodlight had been re-designed from its "gallery reflector" appearance to become a highly efficient long-throw "Caliban" floodlight for use in open-air pageantry. Floodlights and borderlights were compartmentalized and a framed square of gelatin media placed over each compartment. The 1000-watt G-48, C-5 filament nitrogen lamp, and a 1500-watt G56 lamp requested by the industry were developed by 1918 and incorporated into newly designed plano-convex spotlights. Mirrored glass reflectors were available for these spots if desired. Within a few years with the exception of the arc follow spotlight, the theatre had practically discarded the electric arc and was using the incandescent lamp solely; the electric arc was rapidly becoming confined to motion picture lighting.

The desire of the industry to produce more efficient and compact equipment manifested itself in a call for improvement in light sources. The various lamps developed for the industry included: the 1000-watt T-20 projection lamp (1919), the 500-watt T-20 projection lamp (1925), the first practical monoplane and biplane filaments (1930), bipost base lamps (1930), base-up tubular lamp (1933), 100-watt s.e bayonet base projection lamp (1933), 500-watt T-10 medium prefocus base-up lamp (1935), etc.

An existing square prismatic lens had been introduced into spotlight equipments in the late twenties. Its distribution was unsatisfactory, however, and after considerable experimentation a Fresnel lens was designed and introduced. This gave a soft-edged highly efficient spotlight which far surpassed the performance of the plano-convex units. By 1936 a complete range of Fresnel spotlights . . . 250 watts to 5000 watts . . . had been catalogued.

For the downlighting in the Center Theatre an ellipsoidal reflector unit with a "pin-hole" ceiling opening was designed (1932). This first ellipsoidal reflector unit used a 250-watt or 400-watt G-30 lamp. When it was decided to manufacture an ellipsoidal reflector spotlight for theatre use it became apparent that in the larger wattage units the base-down lamp would result in insurmountable problems of heat dissipation and lamp replacement. This forced the development of 1000-, 1500- and 2000-watt base-up tubular lamps. The new spotlights first appeared in the catalogs of 1933. They proved to be two to four times as efficient as the



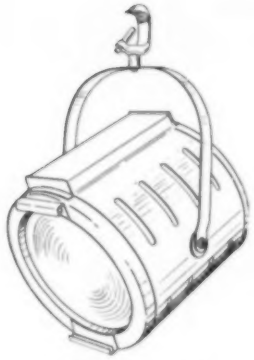


Figure 19. (left) Typical of the earliest ellipsoidal reflector spotlights was this unit which used a 1000-2000-watt base-up tubular lamp developed especially for it.

Figure 20. (center) Present day Fresnel spotlights are similar to this unit and are available in a wattage range of 100-10,000 watts with lens diameter from 3 to 24 inches.

Figure 21. (right) The ellipsoidal reflector spotlight of today is available in wattage range of 250-5000 watts and with lens diameter of 4½ inches to 12 inches.

plano-convex lens spotlights, and with shutters or an iris at the conjugate focal point of the ellipsoid a very useful framing spotlight resulted. The Fresnel lens spotlight and the ellipsoidal reflector spotlight quickly became the major instruments of theatre lighting and have remained the primary equipment ever since.

The first of the ellipsoidal reflector downlights and spotlights were equipped with reflectors of which the mirror surface was an electrolytic deposit of gold, rhodium, and copper. This gave a fairly permanent surface of about 74 per cent reflectance. By 1935 the Alzak process reflector with its 85-90 per cent reflectance had been incorporated into the ellipsoidal units and was rapidly being assimilated throughout the entire line of reflectors for all equipment. The Alzak reflectors proved especially valuable in striplight equipments and by the middle thirties the expensive mirrored glass reflector and the glass castings for theatre reflectors were obsolete in view of the efficient, lightweight and unbreakable Alzak process reflector.

Along with progress in lighting instruments in this period there was also important development work on remote-control systems. Remote-control color systems of the mechanical or tracker-wire type had been installed in a few theatres long before even incandescent lighting. Prior to 1906 remote-control color wheels were available driven by a clockwork mechanism engaged by an electromagnet. By 1918 these systems were operated by motors. During the late twenties and early thirties considerable development took place with the introduction of magnetically and selsyn-motor operated changers. These allowed for the first time the ability to choose any desired color rather than "rolling" from one color to the next.

Remote directional-control systems of the tracker wire type were, again, available prior to 1906. Periodic attempts were made throughout the twenties and thirties to completely operate a spotlight by remote-control. All of the systems developed were subject to the most minute adjustment and none were ever economically feasible.

Intensity-control of light was more successfully achieved. Manually-operated resistance dimmer boards with switching presets, interlocking, mastering, and grandmastering, and slow motion controls, reached very complete development during the twenties. Motor-operated resistance dimmer control systems were commercially developed during the same period. In the middle thirties the first commercial auto-transformer dimmers were marketed for theatres with alternating current supplies, and the elaborate control systems of remote operation by motor, switching presets and the like, were gradually incorporated into installations.

A reactance dimming system had been installed in the Earl's Court Exhibition Theatre as early as 1896 but this type of dimming had never received popularity in the theatre due to the weight and size of the equipment. The duplication of equipments required for feeding both alternating and direct current voltages also made these systems expensive. In 1922 a resistance controlled reactor was installed in the Cleveland Public Auditorium and in 1925 a tube reactor was developed for the Chicago Opera. There were several installations of the tube

type in the late twenties and early thirties including the Mexico City Opera House, Severance Hall in Cleveland, the Metropolitan Opera House, the Center Theatre, the University of Iowa, and Stanford University. The most complicated and elaborate tube reactor of all . . . the Radio City Music Hall switchboard . . . was installed in 1932. This board had 350 separate controls with five-scene dimming preset.

Progress: World War II and After

During World War II the theatre lighting industry mobilized as a whole for the war effort. Distinctive contributions were made in the form of military searchlights and floodlights, camouflage devices, fighter pilot night vision training systems, parts for the Waller anti-aircraft gunnery trainers, non-electric high power portable lighting equipment for jungle fighting, scanning devices for selection of quartz crystals for Signal Corps electronic devices, etc.

In the period following the war there has been a redesign of most of the standard line fixtures, particularly with a view towards greater efficiency and adaptability. Studies have been made of reflector and lens design, methods of improving ventilation, lamp mounting and adjustment systems. New lamps such as the 3000- and 5000-watt base-up tubular types have been requested and made available for use in spotlight and scenic projector service. The 2100-watt, 60-volt projection lamp with its relatively small filament area has provided the incentive for a restudy and redesign of an entirely new line of scenic projectors for use in theatre and television. Projector and reflector lamps, used by the industry soon after they were developed in 1938, have been incorporated into striplights and special spotlight equipments.

Figure 22. A glimpse of the vast array of stage lighting equipment required for today's productions. This, of course, shows only some of it, all skillfully manipulated for numerous spectacular or dramatic effects.

The television industry has encouraged the study of equipment handling, focusing and mounting problems. Units manually operated by poles from the floor have been introduced, and experimenta-

Figure 23. Spectacular scenes such as this at Radio City Music Hall, are now commonplace, and lighting design for stage effects is a recognized art, highly respected in mid-century theatre.

Photo: Kull & Pellino

tion continues towards designing a successful remote-control spotlight. Composition color media of considerably greater permanence than gelatin have been introduced, and special process glass filters are available in permanent colors in a very complete color range.

The most striking advances, however, have been made in the field of switchboard control. The old concept of stage circuits being tied directly onto the dimmer output has given way to interconnecting systems so that one dimmer circuit can be utilized in several ways during the course of a production. Rotary selector switch and counterweighted cord cold-patching systems are available and have eliminated the danger of the open busbar patching system or the pitting of the old-type hot-patch plugging. The interconnecting system is an essential component part in a typical installation.

The commercial introduction of preset intensity switchboards occurred in the early fifties. A large number of preset switchboards employing high-current thyratron tubes have been made and installed; these have provided perhaps the most flexible control over stage lighting yet devised. Recently the redesign of saturable reactor circuits and the use of selenium rectifiers has resulted in the introduction for the first time of workable dimming circuits of this type; the present systems are being known as magnetic amplifier dimming systems. Circuits for presetting of not only intensity but of interconnecting as well have been designed. Fluorescent dimming using either electronic tubes or auto-transformers is feasible and systems of the latter type have been prominently used in architectural installations although not as yet in theatre lighting.

A number of developments are currently in the experimental stage and hold great promise for the continued development of theatre lighting equipment. A few which may be introduced into theatre lighting within a few years include: memory circuits, punch card or tape devices for recording an unlimited number of lighting presets; zirconium and xenon-arc lamp specialty equipments; extremely wide-angle projection systems; dichroic filters and reflectors for alternate rejection or transmission of the infra-red component of the incandescent lamp; the use of the same band filters for color control problems; projector and reflector lamps capable of precise matting; fluorescent dimming systems capable of extreme smooth intensity variation from full intensity to off and reverse; light amplifiers; cyclorama washers which will spread an even high intensity sheet of light over a large vertical surface from very close by. Developments such as these offer great hope for the continued progress of theatre lighting . . . it is to be hoped that the one-hundredth anniversary issue of ILLUMINATING ENGINEERING will reflect the next fifty years of theatre lighting history as another golden period of progress.

I.E.S. Emblem — Available during Anniversary Year For Use by Sustaining Members

During this 50th Anniversary year, Sustaining Members of the Society have been granted the privilege of using the I.E.S. Emblem in their advertising. A special insignia utilizing this symbol of the Society has been designed for this purpose; with reproduction proofs available from the Publications Office of I.E.S.

This privilege, which has never before been extended, will be in effect for Sustaining Members only during the entire year of 1956.

DAYLIGHT—

Man's Great Heritage

PERHAPS you will take as a note of cheer the fact there have been no taxes levied on your castle windows for many years. You can now "picture" them as large as you like without government interference. They may be glazed with flat glass, light-directing glass block or low-transmittance plastics, to name a few of the materials which have been developed for windows. Their arrangement in the structure may be in a saw-tooth roof, as a "bubble" skylight, as a clerestory window or in monitor construction, to mention a few more daylighting developments. And, of course, the daylight itself may be controlled by a variety of means, some antedating by many years the 50-year span of I.E.S. — some by means of recent developments.

In daylighting practice today, the designer's interest is divided (as in electric lighting practice) between the maintenance of recommended illumination levels and the control of brightness in the field of view. In many respects, the greatest differences and the greatest similarities between developments in electric lighting and daylighting over the past 50 years have been in their attack on these objectives. For quite some time, the daylighting efforts of necessity were directed at increasing window areas in order to raise the maintained level. During the same period the electric lighting program was aimed at raising the efficiency of their light sources with the same objective in mind.

By 1940, the success of these programs had begun to relieve the primary need for further up-grading of minimum maintained levels and more and more time and attention have been directed since at control. Here the daylighting and electric lighting philosophies seem to differ. Reflecting some of these basic differences the Daylighting target has been "variation within comfort limits," whereas the electrical objective seems to be "uniformity" per se.

In daylighting, tasteful, effective utilization is the common underlying assignment and the application of new knowledge and devices is as often in the hands of architects as of engineers. This means that Daylighting has been, is, and more often will be *built into* rather than merely "applied" to the building.

This leads naturally to two of the knotty problems of daylighting, *i.e.* measurement and prediction. Perhaps more specific technical effort has been devoted to these phases than to any other.

In 1950 the I.E.S. Daylighting Committee released the first Recommended Practice of Daylighting. In 1953 this Committee, sponsored a complete session of the I.E.S. National Technical Conference devoted to daylighting with principal emphasis on measurement. During 1956, the I.E.S. Daylighting Committee will draft its first procedure on measurement. Its deliberations indicate that general recognition of a prediction method soon may be forthcoming. Because of the time-factor characteristic of daylighting measurement, precision in this

field has depended on and has spurred the progress of photoelectric measurements. For example, the most "stable" photocell available was created for the National Bureau of Standards in 1950 by Weston for use in a continuous daylight illumination recorder required by the U. S. Weather Bureau.

Current daylighting practice has behind it a strong foundation of researches in natural illumination. Some indication of the extent of this is the bibliography of the Recommended Practice of Daylighting itself. No less than 212 items of published material document its recommendations. Basic studies have established the foundation of the advances made, many of them undertaken during the first 30 years. Leading the way to our current knowledge have been the research of such men as Higbie, Younglove and Bull at the University of Michigan; Benford at Schenectady; Waldram and Troller in England; Ives and Knowles in Washington; Kimball and Hand; Abbotto, McAllister and Randall. These, among others, laid a strong foundation for the consolidation of achievements of the past two decades. And still the studies continued — by Brown at Stanford; Pleijel at Stockholm; Biesele and Griffith at Southern Methodist University, Boyd and Bull at Michigan; Caudill, Reed, Evans and Vezey at Texas A & M; Moon and Spencer at M.I.T.; Folsom, Harmon, Hulbert, Rapp and Baker; Spencer Kingsbury, Billhartz and McKinley; Allphin; Allen, Walsh and Smith in England; Bursch, on the west coast.

Such studies have established basic information on, for instance, the relationship of room proportion for maximum use and distribution of daylight within the room; the predetermination of daylight by calculation; the effect of reflected surround; the control of daylight in school design, and many many other factors in the daylight environment.

Architectural Trends

Architectural faith in the advantages of daylighting is evident in the current trend for window-wall, picture window, and glass-clad type of structure that is an increasing part of today's skyline. The source and character of the architects' vision warrant full attention. Further, their challenge is being met, in many a laboratory. The trend of developments toward complete "control" of light and heat flow is already well established as evidenced by the availability and acceptance of such products as light directing glass block, Koolshade screen, Thermopane, Twindow, Twindoweld, Dusklite, and Lo-Tran. Work now being initiated in the creative minds of researchers in laboratories throughout the industry promises much beyond the realm of current thinking.

The scientists in daylighting research, however, are but delving deeper into a subject everyone knows to some extent. Ever have fun on a picnic? Ever char a leaf or wisp of grass with a "burning glass"? Draw a line at a north window drafting table? Relax on a patio? Ever take a light reading with a photographic meter? No doubt everyone has enjoyed these experiences many times. If these have not given you an "expert" or "enthusiast" rating, at least you are an informed layman in the daylighting field and have a firm foundation for fruitful discussion with the experts on a phase of the subject that will grow steadily in technical and commercial importance with the years.

The Southern part of Florida and a few counties in New Mexico receive each year from the sun as much energy as is used in all the United States for all purposes — including power, heat and light. Though not yet upon us, practical utilization of this tremendous power reservoir is approaching. In Phoenix during the Fall of 1955, a group of renowned scientists, economists, and businessmen met for the purpose of programming a long range conversion to dependence on this solar power reservoir.

For the present, your personal interest in solar power may be more closely related to the commercial availability of a solar hot dog and hamburger broiler that has recently been the subject of commercial promotion, or perhaps in Bell Telephone's Solar battery of which the conversion efficiency has recently increased from 6 per cent to 11 per cent. A sizable 1955 grant to the University of Wisconsin by the Ford Foundation is evidence of strengthening support of the field; GM's "solar" automobile is an inspirational peek into the future.

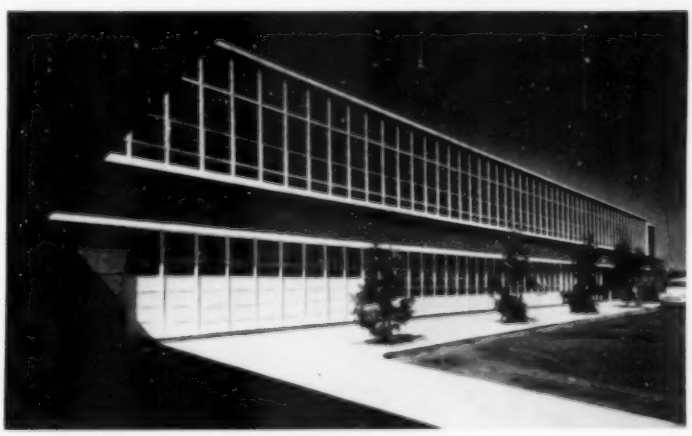
The brilliant sun — a god adored by ancient people — that daily brings renewed faith and hope for the future — enabled our ancestors to see to hunt, to weave, to till the soil, to live! Mankind's visions and development through the centuries have been built by his eyes with light from that ancient sun. Daylight is one of man's greatest heritages — God's created complement to the human eye.

To extend this natural order to things in today's civilization where man is sheltered from the heat and cold, and the winds and the rains, is the earnest endeavor of architects, engineers, manufacturers and research teams — to bring daylight into homes, school rooms, offices, factories.

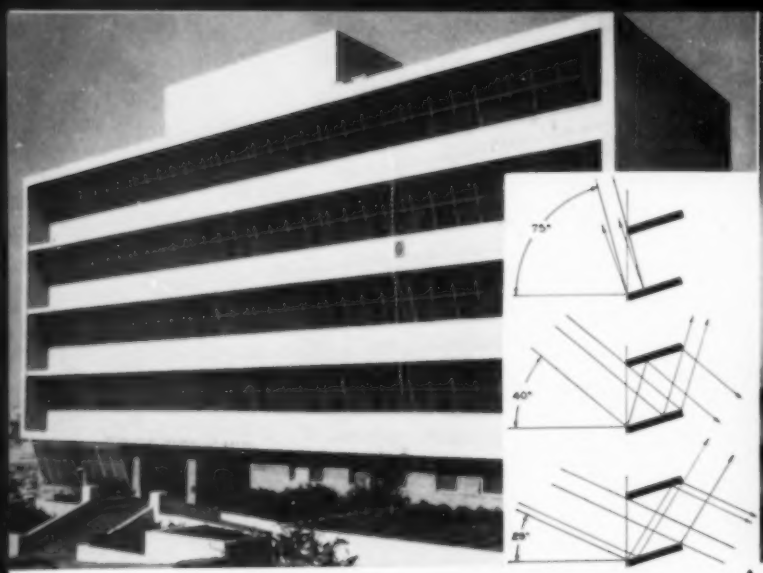
Along this well traveled road various milestones of progress are of particular interest. These listed here are but a few of many worthy of mention:

Edgar Kaufman Residence, Colorado; Richard J. Neutra, Architect.

High School, Norman, Oklahoma; Caudill, Rowlett, Scott and Associates and Perkins and Will, Architects and Engineers.



North of the River High School, Bakersfield, California; Alford and Thomas, Architects.



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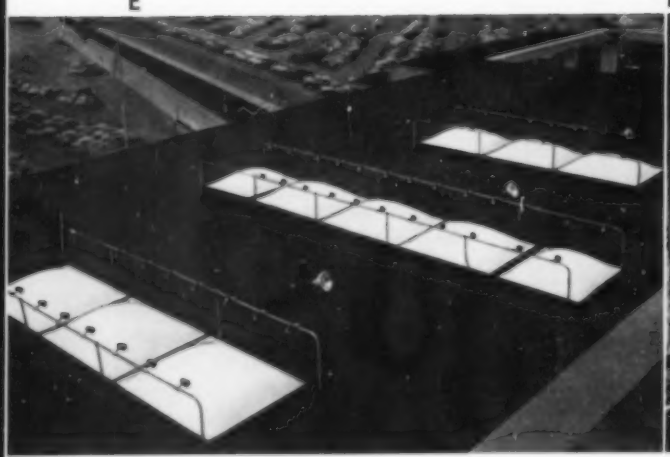


MILESTONES IN DAYLIGHTING PROGRESS

1900 — Development of wide-span construction.

1907 — Steel windows introduced — Detroit Steel Products Co.

1917 — Camouflage, Daylight and Sky Brightness Studies, Long Island and Florida — Sponsored by Thomas A. Edison.

Development of steel and aluminum sash to increase effective glass areas in fenestration.

Development of widespan construction encouraged general use of large fenestration openings.

1919 — Daylighting Statistics collection — Dr. Kimball, Washington, D. C., U. S. Dept. of Health.

1923 — Research on Daylighting in Factories — H. H. Higbie and H. S. Bull, University of Michigan.

1924 — Research on daylighting from windows — H. H. Higbie and G. W. Younglove.

1925 — Solar eclipse measurements.

1933 — Heat-absorbing plate glass introduced.

1935 — Glass block introduced — Owens-Illinois Co.

1938 — Research on Daylight in classrooms — L. H. Brown, Stanford University.

Research on Daylight Measurements — Rapp and Baker.

Development of double glazed window units.

1939 — Glass Center, New York World's Fair.

1940 — Photo-controlled electric lighting.

1942 — Studies on illumination from a non-uniform sky — P. Moon and D. E. Spencer.

Development of light-directing glass block.

1945 — Studies on luminous environment in daylighted classrooms — Willard Allphin.

Coordinated classroom studies — D. B. Harmon.

Development of plastic "bubble" skylights.

1947 — Studies on duration and intensity of sunshine — Frank Benford.

U. S. Weather Bureau Daylight Recording.

Development of Fiberglas reinforced plastics.

1948 — Research on Daylight in Schools — R. M. Biesele and J. W. Griffith, Southern Methodist University.

1950 — I.E.S. Recommended Practice of Daylighting.

Interflections in Daylighting — D. E. Spencer, H. Kingsbury and R. W. McKinley.

Development of photo-controlled exterior louvers.

1951 — Largest Plate Glass Panel — 50 ft. by 8 ft. by 3/8 inch — Pilkington Bros., England.

1952 — Studies on lumen method of daylighting design — R. M. Biesele, W. J. Arner, E. W. Conover.

Studies on Ground Reflection — J. W. Griffith, O. F. Wenzler, E. W. Conover.

Photos on the facing page

A — Medical Research Building, University of Southern California; Albert C. Martin and Associates, Architects.

B — Bishop Dubourg High School, St. Louis, Missouri; Murphy and Mackey, Architects.

C — Kelsey Hayes Wheel Co., Plymouth, Michigan; Giffels, Vallet and Rosetti, Architects and Engineers.

D — McGee School, Rivera, California; Kistner, Wright and Wright, Architects.

E — J. L. Hudson Co., Detroit, Michigan; Victor Gruen, Architect.

F — Southwest Elementary School, Evergreen Park, Illinois; Bryant and Walchi, Architects.

Lever House, New York City; Skidmore, Owings and Merrill, Architects.

Fayette County Hospital, Vandalia, Illinois; Pace Associates, Architects.

1953 — Daylighting Session — I.E.S. National Technical Conference.

Development of selective transmitting glass block.

Development of low transmittance glazing.

1955 — Concept of terrain and landscaping as predictable part of daylighting design — R. H. Reed and Matthew Nowak, Texas A. & M.

Notable Buildings

1933 — Chicago World's Fair Glass House.

1939 — Glass Center, New York World's Fair.

1948 — Equitable Building, Portland, Oregon.

1949 — Johnson Wax Tower — glass tubing in fenestration. Frank Lloyd Wright, architect.

Solar House, Dover, Mass. Maria Telkes.

1950 — All glass house, New Canaan, Conn. Phillip Johnson, architect.

1952 — Lever House, New York City. Skidmore, Owings & Merrill, architects.

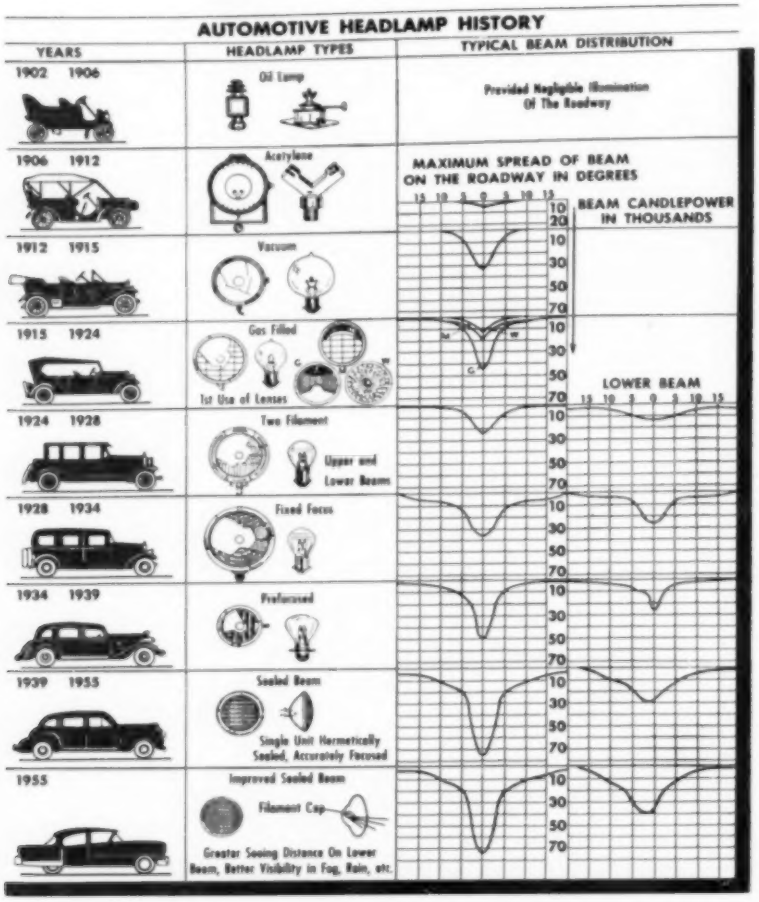
1953 — Lake Shore Apartments, Chicago. Miss Van de Rohe, architect.

1955 — Manufacturers Trust Co., New York, all glass branch bank. Skidmore, Owings & Merrill, architects.

Automotive Lighting

1906

1956



THE MOTOR VEHICLE INDUSTRY was a lusty infant at the time the I.E.S. was born. In the year 1906 33,200 passenger cars, 800 trucks and buses were produced. The lighting, if any, was by means of oil lamps.

The Society of Automotive Engineers had been formed in 1905. It later was to join with the I.E.S. in developing performance specifications for lighting equipment.

The oil lamps of 1906 were adequate for the prevailing conditions of road and speed. However, there was a recognized need for more powerful headlights which led to the acetylene headlamp — really a spotlamp which was employed during the period 1906-1912. It is said that Carl G. Fisher built the famous Indianapolis Speedway (1909) with profits derived from the Prest-O-Lite method of combining acetone and acetylene as an illuminant for automobile lamps.

An interesting and probably accurate anecdote[1] is told of Charles F. Kettering's early association with Carl G. Fisher.

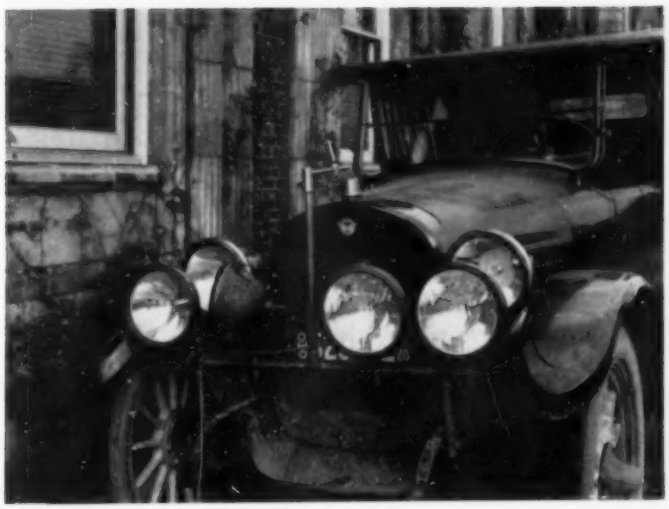
Kettering had developed a revolutionary type electric motor to operate a cash register, and in 1909 set out to solve the problem of battery-operated electric ignition for automobiles instead of magneto operation. He sought and obtained Fisher's permission to use the Indianapolis track to "try an experiment." Kettering had installed electric lighting as well as the novel method of electric ignition on his experimental car. The speedway superintendent watched the experiment for a while and then went to the front office to consult Fisher.

"Who's the fellow you let use the track?"

"Oh, some nut from Dayton who thinks he's got something," Fisher replied. "I didn't like to discourage him."

"Well," said the superintendent, "that nut is

1920 test car.



using your Speedway to put you out of the automobile lighting business."

But Kettering was not alone in working on electric lighting for automobiles. Incandescent lamps with carbon filaments were available for automotive use as early as 1908. On July 15, 1910, Bulletin No. 12 of the Engineering Department of the National Electric Lamp Association entitled "The Electric Lighting of Automobiles" gave practical technical data on Automobile Electric Lamps and Lighting.

The advantages of electric lighting as listed on page 3 of this bulletin seem worth quoting:

(1) The Chauffeur can "light up" without leaving his seat.

(2) Highly efficient silvered reflectors can be used since there is no excessive heat to cause deterioration of the polished surface.

(3) The Lights cannot be blown out.

(4) There is no water to freeze. (Storage Battery Electrolyte freezes at a temperature considerably below 10° Fahrenheit).

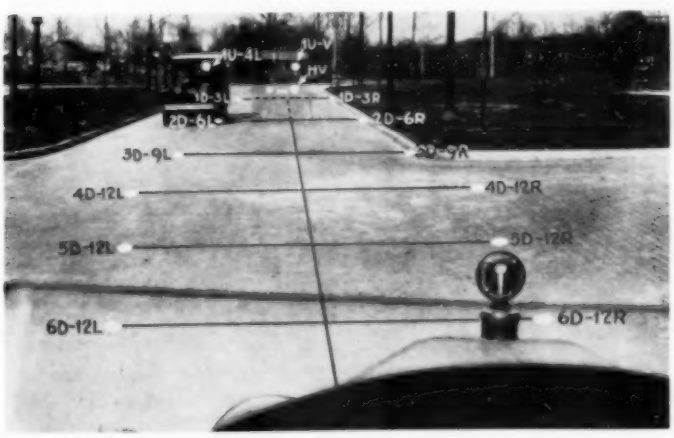
(5) The lamps can be used with safety in the presence of inflammable gases.

(6) Portable trouble lamps may be carried, eliminating entirely the use of matches about the machine.

Incidentally, of all the lamps and lighting devices first introduced as accessory equipment, the trouble lamp cited in this 1910 bulletin is the only major device of the type which did not eventually become standard equipment.

Electric headlighting became standard equipment on some cars in 1911 and the use of electric headlamps, tail lamps and instrument lamps was fairly widespread following the introduction of Kettering's electric starter in 1912.

Gas-filled incandescent lamps were introduced in 1915; also in 1915 a few states followed the lead of Massachusetts in adopting regulations prohibiting glaring lights and defining distances at which objects should be made visible by the headlights.



Circa 1920. Beam pattern related to passing cars.

Thus was started what has continued to be a constructive interest on the part of State motor vehicle administrative authorities.

The period 1915-1920 saw a profuse variety of headlight gadgets and "glare-preventing" devices. There was also quite a battle between the practices of resistance dimming and diffused glare — both entirely unsatisfactory.

The first joint I.E.S.-S.A.E. specifications of optical performance of headlights on the road were adopted in 1918. These were predicated upon the use of one beam only. Considering the prevailing speeds of the time, a single fixed beam could at least theoretically do an acceptable job of lighting the road without glare. However, aiming variations, coupled with the variation in vertical contour of the road resulted in much discomfort as well as inadequate seeing.

Encouraged by such pioneers as W. F. (Bill) Little of Electrical Testing Laboratories, the I.E.S. Motor Vehicle Lighting Committee and the S.A.E. Lighting Division continued to study motor vehicle lighting problems with the view of developing adequate specifications as a guide to manufacturers and state motor vehicle administrative authorities.

In 1920, Mr. A. W. Devine[2] of the State of Massachusetts, used a "dark room over 60 feet long" and instrumentation put at his disposal by the General Electric Company to determine the light distribution characteristics of some 30 headlamp devices. Then, over a period of some months he made road tests using the lamps measured in the laboratory.

At almost the same time, a similar study was made at Nela Park by H. H. Magdsick and R. N. Falge.[3] They used a combination of laboratory-assembled lamps to vary the beam patterns at the will of the observers.

These two studies greatly influenced a 1922 revision of the I.E.S.-S.A.E. photometric requirements at specified points.

There followed a number of better designed headlamp units incorporating optical control by means of lenses with spreading flutes and bending prisms, or by modified reflector sections.

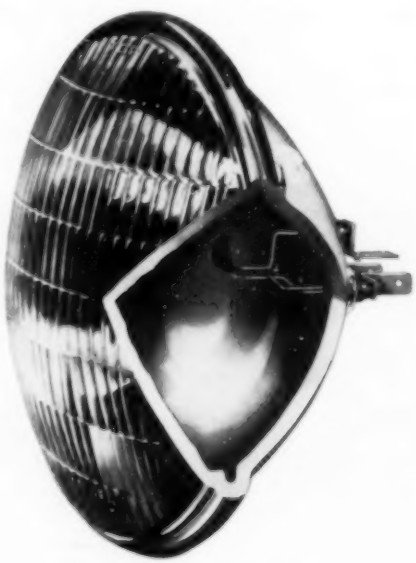
The next great step forward in headlighting performance after the replacement of oil and acetylene by the electric lamp came with the two-beam headlamps in 1924, produced by the two-filament lamp. It became recognized that the single, flat topped beam, meeting the 1922 IES-SAE specifications, did not project far enough ahead for really safe seeing. If it were aimed below the horizontal ever so slightly it would still give serious annoyance yet not project far enough ahead to provide seeing distances more than stopping distances. So the accepted solution was an upper and a lower beam. The upper beam then — and now — should be used only when no car is approaching within 1000 to 1500 feet. The lower beam then and now should always be used when approaching cars are this close.

In 1925, the number of lamps on the average car, as produced at the factory, was 5½ — two headlamps, a tail lamp, two side or parking lamps and perhaps a dash lamp. But accessories installed by the owner were popular. These included stop lamps, turn signal lamps, spot lamps, fog lamps, driving lamps, trouble lamps and various interior lamps, most of which have since become standard equipment, at least on deluxe models. In 1926, a pamphlet of the Automotive Lighting Association shows 18 lamps on "The Well Lighted Car for Safe and Pleasant Motoring."

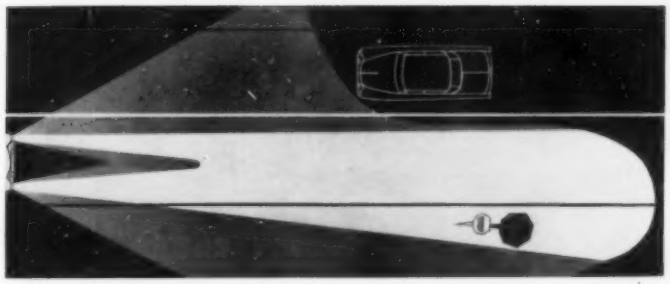
Another 1926 milestone worthy of mention was the adoption of the uniform vehicle code. This service — and as revised periodically — continues to serve as a model traffic code to the States. It contains broad provisions on lighting equipment in the interest of safe operation.

Headlighting was improved in 1928 through the general adoption of "Fixed Focus" designs. Adjustable focusing mechanisms were discarded in favor of reflectors of larger diameter and longer focal length. These were less sensitive to variation in filament positioning.

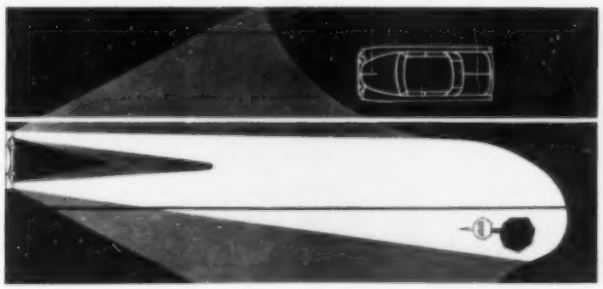
Asymmetrical lower beams appeared on some cars in 1932, with advantages recognized in a previous SAE paper[4] (Note). Additional light directed farther ahead along the right side of the



Sealed beam headlamp.



Better lower beam — up to 80 feet more seeing distance at side of road.



Comparison — older beam pattern.

road improved visibility for passing and helped the driver to concentrate his attention in this area.

During the period 1933 through 1939, many cars had headlamps providing three beams, and one model had four beams. In this period, the size and shape of the headlamps became a style feature, even varying between models of the same make. Often the right and left headlamps were different too. In some cases the left headlamp lighted only the right side of the road, and in other cases the right headlamp was used to light the right side of the road. By this time (1930 through 1939) bulb candlepower (headlamp) was generally 32, up from 21 of the original electric headlamps.

In 1934, headlamp bulbs became "prefocused." A separate "collar" was soldered to the base after manufacture of the bulb was completed. This collar was optically aligned with the filaments, and in turn seated directly against the reflector. This provided more accurate alignment of the filaments with respect to the focal point of the parabolic reflector, and thus permitted use of reflectors of shorter focal length and lesser diameter.

The variety of designs, shapes, sizes, and arrangements of headlamps during the period prior to 1939 led to a certain amount of misuse, and a general lack of service understanding. In this same period independent research efforts by Finch,[5] Goodell and Johnson,[6] and Roper[7, 8] established relations between beam candlepower and seeing distances and the effect of glare upon seeing and comfort. The Nela Park studies by Roper and his colleagues also established an "observer consciousness"[7] or attention factor which may be applied to tests under controlled conditions to establish seeing distance under normal driving condition.

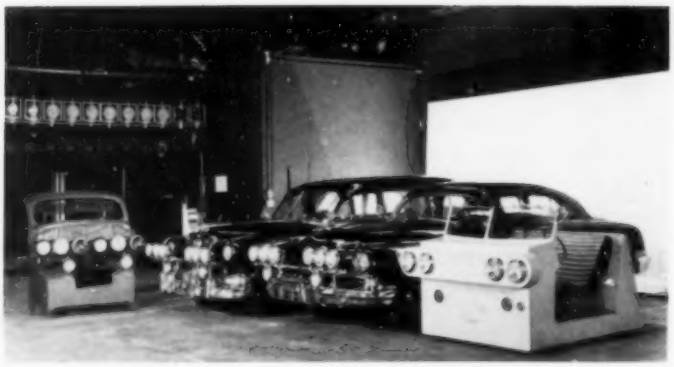
All the data pointed to the need for increased intensities — more light — from the headlamps. (They still do.)

Hence the time was ripe for a major improvement which occurred in the form of a radically new concept in lamp manufacturing. In fact it was the most startling innovation in incandescent lamp manufacturing since Edison's first practicable lamp in 1879. Early in 1937 the automotive industry was advised of a Nela Park engineer's invention of the unit all-glass hermetically sealed headlamp.

In the amazingly short time of 2½ years, specifications were developed for the so-called sealed beam headlamp system incorporating the new all-glass unit, or a physically similar unit subsequently developed and incorporating a metal reflector and soldered-in bulb. The two types were interchangeable physically and produced essentially the same initial lighting results — each manufactured to meet new IES-SAE specifications on headlighting beam performance.

These new specifications recognized the need for increased light output. Hence they called for a 45-watt filament providing the symmetrical upper beam and a 35-watt filament for the asymmetrical lower beam. The maximum beam candlepower was increased by 50 per cent to 75,000.

The system included a simplified holding and aiming arrangement to facilitate service, and it included an upper beam indicator — a red warning light on the dash to signal the use of the upper



1955 test laboratory — cars and laboratory equipment.

beam. Sealed beam lamps were installed as standard equipment on almost all 1940 models.

The period just before World War II saw more turn signals on cars and trucks. Two tail lamps became increasingly popular. Attractive to the stylists from the standpoint of appearance, they also greatly improved the marking of the rear end of the vehicle.

By 1941, the average car produced was fitted with 14 bulbs at the factory (not counting dealer- or owner-installed accessories). The well-lighted car in this period had about 25 lamps installed.

Following the war, lighting of the vehicle kept pace with the trend toward deluxe features: power brakes, power steering, power seat adjustments, power window lifts, automatic transmissions. The "dream" well-lighted car of 1926 with its 18 lamps is surpassed by the "standard" factory installation of 1956. The "average" 1956 model has 23 bulbs — 5 more than in the average home! And the performance of lighting equipment other than headlamps has steadily improved. SAE specifications on tail and signal lamps have kept apace of the traffic situation. They were again revised upward in 1955.

A post-war development not in lighting but in lighting control brought the first factory-installed photo cell dimmer in 1952. This continues as an optional accessory.

The 1956 models have the new improved sealed beam headlamp introduced to the replacement market late in 1954. These feature a better lower beam which provides up to 80 feet more seeing distance[9] along the right side of the road, in clear weather. A "fog cap" (see illustration) over the filament providing the lower beam and special treatment of the reflector axis and lens prisms combine to reduce the "stray" light directed above the horizontal. The result is considerably increased visibility under conditions of fog, rain and snow.

The wattage was increased to 50 for the upper beam and 40 for the lower beam.

This improvement was further evidence of the continued interest and influence of state motor vehicle administrators in the automotive lighting problems.

Back in 1937, the engineering committee of the AAMVA worked very closely with the industry group in the development of specifications for the sealed beam system. The first chairman of that committee, Jim Shanley, was also a pioneer in the operation of one of the most successful state periodic inspection systems. Looking to the future, herein lies one of the best opportunities for better headlighting performance. Periodic inspection, properly organized and conducted, can insure progress toward *exact* headlamp aiming and *exact* headlamp aiming will in turn permit still further improvement in beam pattern design for increased seeing.

But to turn back to the Engineering Committee of the AAMVA, in 1950 it requested the industry's consideration of steps to improve the lower beam of the sealed beam headlamp. It approved the industry's efforts in June of 1953 and under the leadership of George Kenneipp of Washington, D. C. and W. L. Cross, Jr. of Connecticut it continues to cooperate with the industry, the SAE, and the IES with the objective of ever-increasing safety and comfort on our roads at night.

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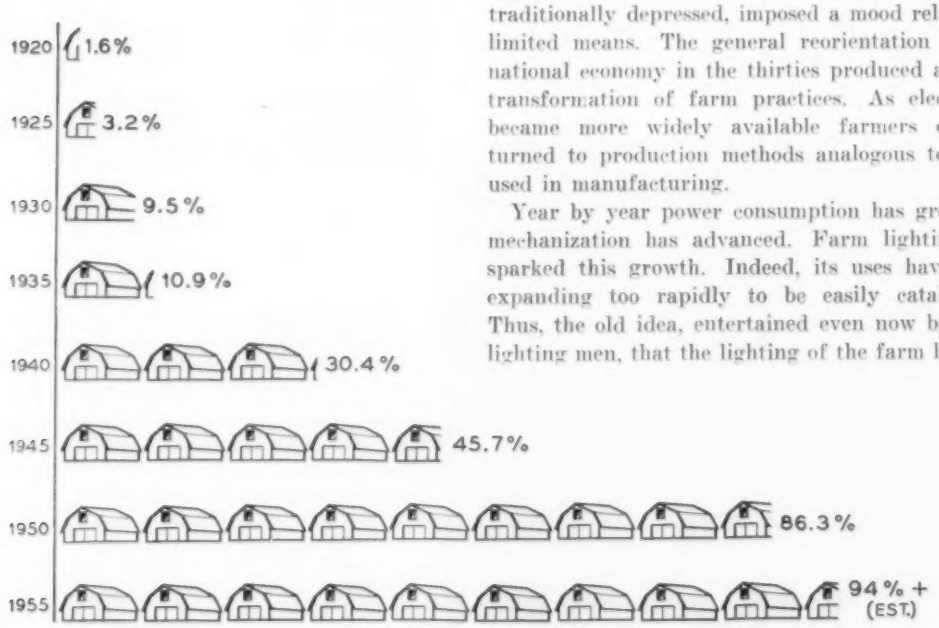
LIGHTING ON THE FARM

FIFTY years after the electric lamp had been developed, most U. S. farmsteads were still using kerosene lighting. Such farm lighting that existed on the fringes of cities was limited and substandard. In the decade between 1930 and 1940 the percentage of farms with electric service nearly tripled. In this decade, paralleling the rise of farm income toward the end of the period, lighting standards advanced substantially. Nevertheless, the rapid electrification of farms in the thirties was primarily a power development.

In retrospect, it was, perhaps, an advantage to agriculture that electrification came *after* the big urban development. In an old industry like farming, tradition could resist change. Farm income, traditionally depressed, imposed a mood related to limited means. The general reorientation of the national economy in the thirties produced a rapid transformation of farm practices. As electricity became more widely available farmers quickly turned to production methods analogous to those used in manufacturing.

Year by year power consumption has grown as mechanization has advanced. Farm lighting has sparked this growth. Indeed, its uses have been expanding too rapidly to be easily catalogued. Thus, the old idea, entertained even now by some lighting men, that the lighting of the farm home is

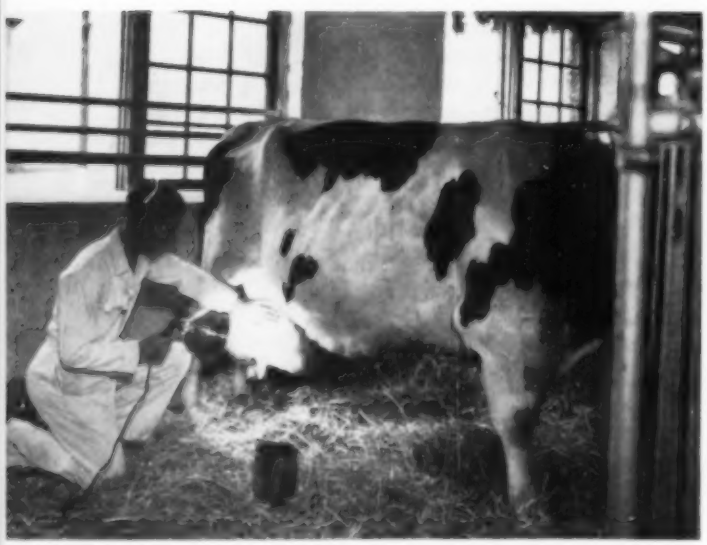


Percentage of farms electrified, 1920-1955. Each barn represents 10 per cent.

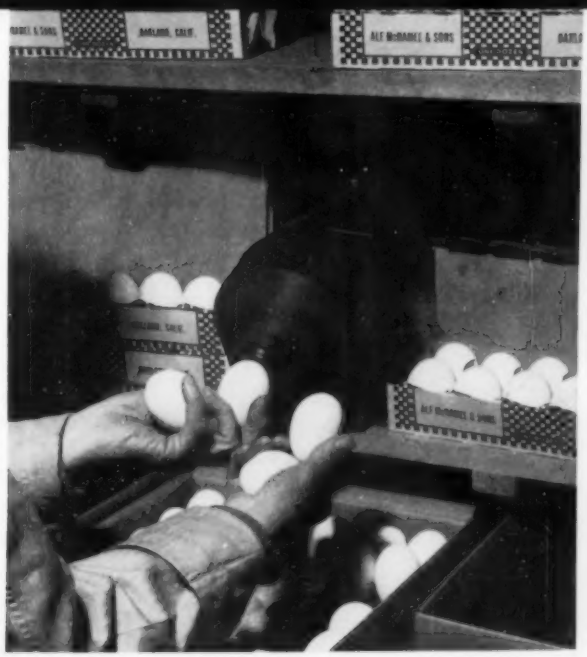
MILKING TIME for a large herd in a well lighted dairy barn proceeds with care and dispatch. Maintenance work is expedited, too, with ample light to insure thoroughness.

its focus of interest, has not been *true* for years. The home is only one of several foci in the phenomenal extension of lighting applications to farm uses.

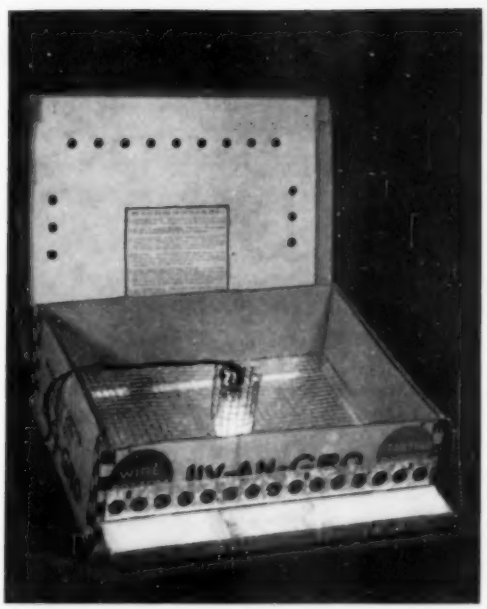
Industrial, and even commercial lighting techniques have been taken over so rapidly in rural areas, farm lighting counselors will have to keep acquiring new specializations to keep pace with demand. Lighting has become an instrument directly involved in farm production as well as for illumination and the service of eyesight. Applications on the farm will presently show the urban market some improvements on the techniques it has borrowed. Right now research into the protean relationship of light to life is suggesting that illumination for the human eye is just a starting point. Plant and animal response to radiation lie in vast new areas largely unexplored. What has been happening in recent years in the farm field leads to a concept of the future wherein lighting by the quarter section or the square mile is a real possibility. We have not begun to comprehend power development on so vast a scale. New fuels, *i.e.*, atomic and solar energy may produce the means for economi-



THERAPEUTIC uses of light are important in keeping cows in good condition. Handy portable infrared units are widely used to treat simple ailments of cattle.



BLACK LIGHT from the small candling unit helps the farmer speed quality eggs to market.

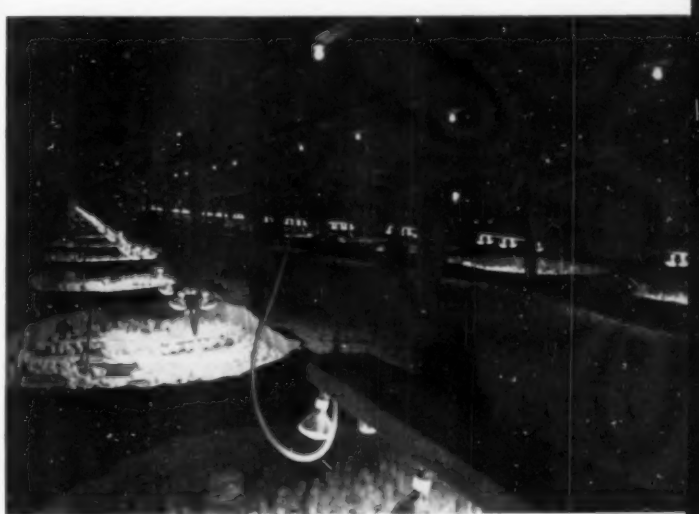


EARLY PRACTICE in brooding was encouraged with cardboard crates for shipping baby chicks, readily converted into a brooder.

cal expansion of lighting directed to field crops and their control.

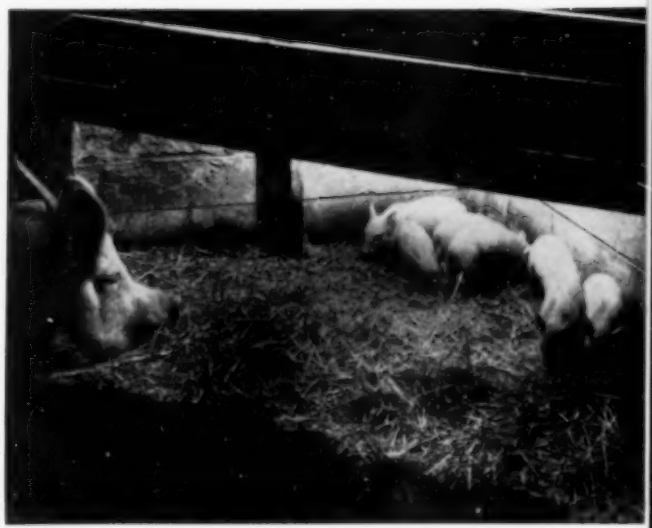
* * * * *

Things were far from being so propitious just 25 years ago. The farm market for lighting was distinctly uninviting. Lamp manufacturers thought of farm uses incident to established demand. Farm lighting for the home and buildings was generally primitive. About that time it was expected that ultraviolet radiation would soon be in large demand as a complement to natural processes. Excitement about vitamins for human health embraced lamps producing ultraviolet. It was argued, that so simple and economical a source of Vitamin D



REALLY SUPER brooder houses have demonstrated production methods in bringing chicks to broiler stage. Lighting incident to the radiant heat provided by the multi-lamp units for each brooding pen makes operations easy to inspect. Constantly replenished feeding troughs invite these comfortable warm little chicks to busy eating and growing. Every three months 20,000 broilers go to market from this house.

TEMPERAMENTAL turkeys take to radiant energy. This is an early installation with industrial reflectors employed to distribute the health giving warmth.



YOUNG HOGS thrive under infrared light.

HOGS have a hard time keeping cool on summer days in the corn belt. They may be too warm to care to eat. When lights are switched on in the cool of night at the feeding pans, hogs are easily persuaded to have a snack. It makes a difference to the farmer getting hogs fattened for market.

had tremendous implications. That may still be true, but events to date have not confirmed the hope. In poultry houses early experiments discovered that good results at first attributed to ultraviolet were really due to radiation in general and *infrared* in particular.

Likewise we discovered that the handy light meter, so helpful in developing standards of early thirties was chiefly useful in showing that we had different categories of measure on the farm. General illumination practice in farm buildings did not follow the logic for standards in lighting city interiors. Flexible equipment, chiefly for localized lighting, directed to specific tasks, usually suited farmers much better. Then we further discovered that the meter's design, following eye sensitivity, was not able to help us to determine standards for animals and plants which have quite different receptivity.

Much experimentation went on in the thirties. The importance of light to growing plants and animals was an obvious but tantalizing fact. How does a plant, for instance, make use of the radiant

SUGAR CANE, a really big field crop, has been shown to be susceptible to a high degree of control with light. This technique promises much larger yields of sugar per acre, since with maturity delayed the cane grows larger.

IN JUNE 1954, a generator was produced for attachment to a tractor, providing a mobile 3-phase power plant of 10 kw capacity operating directly from the tractor. This development makes possible the use of standard voltage equipment in the fields. The illustration shows floodlights and a black light (fluorescent) bug trap mounted on the tractor. Trailer equipment, such as balers, harvesters, or combines, can be equipped with motors rather than separate gasoline engines.

HAY MOWS may be hazardous places to work unless properly lighted. Advanced farm practice goes for mechanical equipment for handling hay, and good lighting helps to keep operations tidy and efficient.

energy it absorbs? Theories flourished and some were fruitful, but most in time had to be abandoned.

In the meantime, farm lighting brought much of the comfort of better illumination to the farm home and higher safety to the farm buildings and chores. Light for specific chores, such as a dairy barn, proved the need for fresh thinking. Seeing tasks there were unique and techniques had to match them.

When World War II came along farm lighting suffered a temporary relapse. This was more apparent than real. Under the urgency of war demand science was mobilized to investigate many fundamental natural phenomena. Hydroponics may be recalled as a system developed for growing vegetables in tank gardens. Chemical nutrients in tanks filled with water and gravel provided one element of growth. Sunlight or artificial light provided another. How was the function of each element combined in the process? This problem continues to provide a fertile field for research.

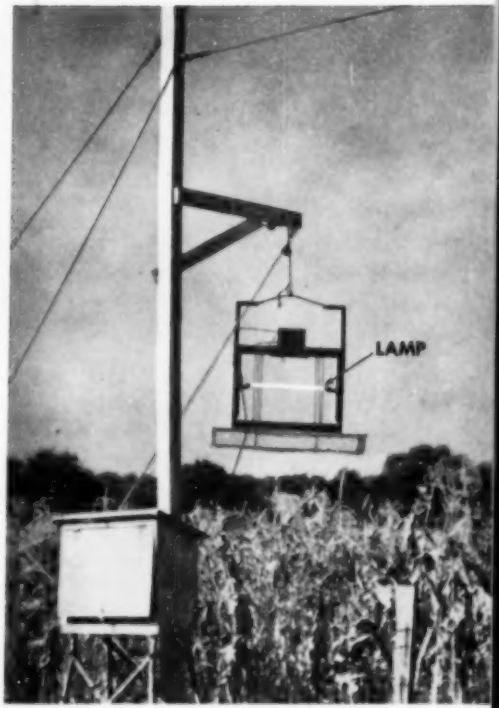
Wartime development of atomic energy has hastened the time when we may know more fully how photosynthesis works. While we await more details of the process some earlier studies have advanced our knowledge a long way.

Photoperiodism, a long word referring to a phase of photosynthesis, has shown us that growth and maturity in living things is intricately related to patterns of light and dark. Long day and short day plants, we discover, are dependent upon short and long nights respectively for maturing. This discovery, confirming research work started 30 years ago, had led already to important commercial implications. Florists, for instance, have won national interest with lighting applied to control blooming appropriately to the most profitable market opportunities.

Control of plant growth and maturity by light-

GARDENIAS are grown with help of 100-watt lamps in RLM dome type reflectors, at the Daisy Hill Farms, Chagrin Falls, Ohio. Lamps burn about six hours per day. Head gardener states that center bench was in bloom about two weeks before outer side ones.

U.S.D.A. LABORATORY with 2000 footcandles for study of light and plant growth.



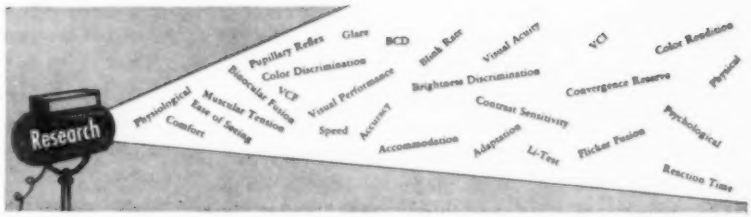
BLACK-LIGHT lamp attracts insects to this trap for electrocution.

ing systems has already reached acreage proportions. Experiments on such important field crops as sugar cane indicate the scope of coming developments. At the same time, hobbyists have gone so far with indoor plant raising that home gardens in winter climates bid fair to become typical.

Application of photoperiod techniques to induce foxes and minks to put on heavy pelts in summer (in time for winter markets) is a related development. Far more important to national markets is the use of infrared lamps for animal brooding. Millions of baby chicks are reared under these lamps to broiler age. Piglets, calves and young lambs get a quicker start to market under these lamps too. Much larger percentages live and thrive this way than when left to survive by natural brooding.

Farm lighting today is just assimilating the effects of 25 years of very rapid growth. This it must do while continuing to expand at an accelerating rate. Since 1950, when IE published its first paper on the modern aspects of light and agriculture, professional interest has grown apace. That paper's propriety was debated on grounds of relevance to professional interest. Once presented such questions were answered by immediate response. Today the society has no doubt about its stake in farm lighting. It is not a field, however, that corresponds to the norms of the older fields of practice. So far the terminology has little to do with footcandles or brightness values or contrasts or reflectances in the customary relationships. It does call for a high degree of professional skill and IES members will continue to find it expanding professional interest with growing opportunities for specialization.

why we are where we are . . . . . Lighting Research



RESEARCH has contributed greatly to the development of our modern world. Product research has given us new things to use, and application research has told us how to use them. This is just as true in *light and lighting* as in any other field of science or engineering. Research has provided us with countless new light sources and many lighting techniques.

Even fifty years ago when the Illuminating Engineering Society was founded and later when committees began to formulate lighting codes, it was realized how little information was available upon which to base their recommendations. Of course in those days, which can be considered an era of mere footcandles, the lighting specialist's main problem was to provide even a little light where it would do some good. He was in a position similar to that of a doctor who had pills in his bag, but didn't know what the proper doses were.

Vision has been studied for hundreds of years. Countless investigators have provided us with a wealth of knowledge about the eye and visual sense. However, most of the early investigators considered light and lighting only incidentally. Thus, much new research was necessary to establish the relationships between light and sight.

The research of any period generally reflects the tools the experimenter has available and the concepts developed by him and his predecessors. Too often the latter have been restricted by limitations of the former. However, as decades have come and gone, our viewpoint has broadened to include many aspects of seeing which must await the future before we will have the answers to all of our questions. Vision research — the study of the capability of the eye to see things — has been broadened into what we now call Lighting Research. This encompasses all aspects of human behavior and response to visual situations in which light and lighting have any degree of importance.

Fifty years ago in his inaugural address, L. B. Marks emphasized that the objectives of our Society include the gathering of authoritative data on the subject of illumination and pointed out the need for research upon which illuminating engineering could grow soundly. Thus, the Society assumed a responsibility which it has faithfully adhered to and executed. During the past half century more than 250 papers dealing with the many phases of lighting research have been published in our journal. Many more, though not directly concerned with fundamental research, were intimately associated with light, vision and seeing. All these papers, and discussions of them, illustrate the great importance the I.E.S. always has placed upon fundamental information. Technical committees have used these data as the bases for their recommended practices.

It is impossible to give credit to all who have contributed to lighting research. However, we can recognize the pioneers who paved the way by their studies and analyses and whose work has encouraged others to add to the essential knowledge upon which illuminating engineering is based. Such names as Cobb, Ferree and Rand, Nutting, Bell, Ives, Luckiesh and Moss, Hyde, are familiar to all. Many others have continued in their footsteps and are contributing materially to the future of the lighting art. Since space does not permit a documentary review of all contributions, this will be

confined to highlighting the progress that has been made in broad concepts and the general pattern of lighting research during the past 50 years as reported in our Transactions.

Science of Seeing

Anyone who reviews the voluminous literature on light and vision cannot help but be impressed by at least one important point: the basic philosophy revolves around the "best" seeing conditions. In other words, the objectives of today are the same as those of yesteryear: to provide the best possible ability to see with greatest ease and comfort. The knowledge at hand was applied to the current methods of lighting practice.

Various approaches and methods have been used by the investigators. Some were dictated by specific and limited personal interests, while others were of a more general nature. Nevertheless, over the years a generally progressive pattern evolved as new experimental techniques and criteria were developed. The needs of the Illuminating Engineering Society and its desire to make every possible use of the information in developing sound lighting practice has served as a continual stimulant to research workers.

We have passed through periods during which emphasis was, in turn, placed upon various avenues of research. Each has contributed materially to the overall problem. Obviously, the greatest effort has been expended on measurable effects of light and lighting. However, less obvious and not directly measurable effects have been kept in mind by many.

The earlier researches usually were confined to studies of the visual sense. Thus, we have comprehensive data on the smallest object and the least brightness that can be seen and on the least amount of time necessary to see a given object. All of these involve evaluations of the threshold — the borderline between seeing and not seeing. Of course, it was recognized that the typical laboratory situations could not be compared directly with those in which people usually found themselves. The ever present problem has been to determine how these laboratory threshold data could be related to the countless, work-world visual tasks for the purpose of specifying light and lighting.

As the investigations progressed, it became evident that *seeing* was what should be studied; in other words, that light and sight are mutually essential partners. Neither was of any value without the other. Thus, there opened up an entirely new vista in which seeing was included as a dynamic activity of human beings. A science of seeing was born. Human efficiency, comfort and welfare were important parts of this new and expanded concept.

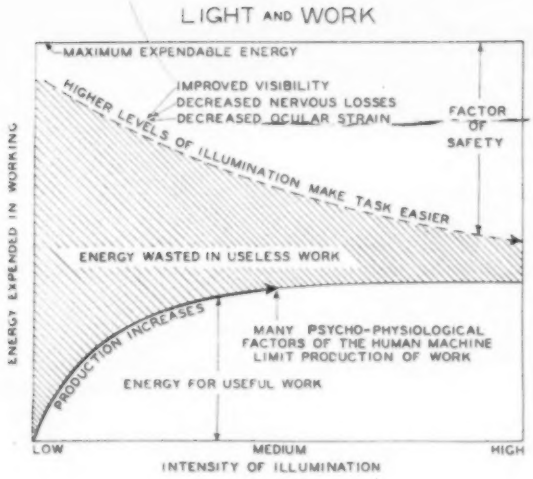
One of the early steps forward in developing this broader concept was made by Luckiesh and Moss. Twenty-five years ago, with some hesitancy, they presented the accompanying diagram in which they attempted to include with definite knowledge an approximation of the unknown. It was an interpretation of the relationships among lighting, production of work and the expenditure of human resources. Thus, for the first time, total human effort and energy were brought into the picture. It seems strange that this new concept took so long to develop because everyone has experienced what the diagram illustrates. For example, when we increase the amount of light on this printed page from a few footcandles to 100 or more, we may not be able to read it more rapidly. But we read it easier and for longer periods without any appreciable fatigue.

Many researchers began to join the ranks of those who were interested in seeing — ophthalmologists, optometrists, physicians, physiologists, psychologists. Even those who more or less confined their work to threshold measurements began to include dynamic conditions in their experiments. Currently there are scores of colleges and universities all over the world where such work is done. A formidable amount of information has become available. The specification of light and lighting is becoming less and less an empirical art and is being based upon logic and a better understanding of how people need and utilize light for seeing.

Visual Performance

Visual performance often is thought of, on a restricted basis, as the capability of the eye to perceive things. As such, it involves measurement of the fundamental factors of size, brightness, contrast and time. On the other hand, it also is considered as a dynamic activity of human beings and includes the productivity of a worker on a typical job. On this basis it is necessary to consider the speed and accuracy with which a task is performed. Obviously, the two approaches are connected. Ideally, if complete information were available, it should be possible to relate work-world tasks to the fundamental factors.

Originally, most investigators used such tasks as reading black print on white paper or the discrimination of black objects viewed against white backgrounds. It is obvious that countless work-world tasks involve lower contrasts and complex configurations. It was impossible to prescribe footcandle levels without some knowledge of the visual effectiveness of illumination with these other tasks.



Many investigators have studied the effects of illumination upon visual performance. Countless others are continuing to add to our knowledge. A significant outcome of these newer investigations is that the data may be presented in terms of per cent of optimum performance. Thus, it is possible to determine the effectiveness of illumination for a task of given size and contrast and thereby judge the economics of increasing the footcandle level to a higher value in terms of the expected improvement on the part of the worker. Another important result of these newer researches is the greater emphasis that is placed upon brightness. This makes the data more universal in their application and emphasizes the need for considerably higher levels of illumination for dark, low contrast tasks. All of this information is being considered by the I.E.S. lighting practice committees when they develop recommended footcandle levels.

Visibility

If detailed performance studies of every work-world task could be made in the laboratory, we would eventually have complete data for specifying light and lighting on this one basis. Unfortunately, this is an insurmountable task. Therefore, it is necessary to develop some other approach that possibly might be related in some way to performance.

All things we look at are not equally visible. Obviously, we can see some things better than others. Can we determine how much light we need on these various objects to make them equal in visibility? Basically, since most tasks are at varying degrees above the threshold of perception, it is necessary to determine how much each is above its own threshold. Any of the fundamental factors of size, contrast, brightness or time can be used as a variable and incorporated in an instrument for evaluating the amount an object is above the threshold.

Instruments designed not only for laboratory use, but also for those places in the work world where visual tasks are performed are now widely used to study school, office and industrial tasks. It is possible to evaluate the visibility of practically any task where it is being performed and, if desired, by the person who is doing it. More recent data have related visibility data to the absolute threshold footcandle level and to the brightness difference threshold. These serve to make it quite simple to determine the footcandles necessary to raise tasks to any desired visibility level. It is readily demonstrable that hundreds and even thousands of footcandles are necessary to provide even a moderate visibility level for many inherently difficult tasks.

At the moment we are not concerned with the practicability of attaining these higher footcandle levels. However, we are interested in developing a single standard for lighting practice. It does not seem right that light for seeing industrial tasks should be recommended on a different basis than for office tasks just because it may be difficult to obtain. Visibility does give us a uniform basis for evaluating these very different types of tasks and provides an indication of the amount of light we should try to make available. The application committees and engineers will have to decide what, at the moment, is an economic compromise.

Ease of Seeing

The measurement of fatigue in general and eye fatigue in particular is very difficult. Much has been written and a number of investigators have studied this. Some have used speed, accuracy or rate of working as a criterion. Even though the subjects report fatigue, there often was no decrement in any of these measures and, in fact, sometimes there was an improvement. Thus, it has been necessary to devise other more sensitive methods or indicators for evaluating fatigue or ease of seeing.

When the chart illustrating the expenditure of human resources was first prepared, the upper dotted curve was an approximation, but over the years, data have shown that this concept was sound. Application of appropriate criteria before and after prolonged periods of working or during the test period have provided useful information. The so-called li-test (time blurred *vs* time clear), nervous muscular tension, muscle action potentials, convergence reserve, rate of blinking, corneo-retinal potentials have been used. At times there has been

controversy regarding their suitability, yet when applied with judgment, the results have been worthwhile.

No absolute method of measurement nor universal criterion has yet been devised. Nevertheless, the indirect evaluations of the effort expended in seeing which have been explored show that higher footcandle levels provide greater ease of seeing and less expenditure of human energy.

Considerably more work is necessary in this area. When subjective observations indicate greater ease of seeing with higher footcandle levels, it is desirable and necessary to develop objective methods of evaluation.

Quality of Lighting

By quality of lighting we mean the distribution of light upon the task and the distribution of brightness throughout the visual field. Part of this involves glare — obviously very bright areas. But it has been found that less bright and even dark areas are undesirable and produce visual discomfort. Quality of lighting also involves visual disability or a reduction in the ability to see. In either case it means that light is being wasted by not performing the desired function of providing quick, accurate and comfortable seeing.

Glare has been an ever present problem in illuminating engineering. In 1906 the Society's first President emphasized the need for information on glare. One of the first appointed committees was assigned this subject. During recent years, since higher footcandles have become more commonplace, quality of lighting has become one of the most important problems in lighting.

Basically, we can divide this problem into two parts. One deals with the brightness of surroundings, such as desks, walls and floors; the other involves the brightness of lighting fixtures. Both must be controlled so that they are in balance with the brightness of the task and with each other. The work of Lythgoe, Cobb, Luckiesh and Moss, and the analyses of Moon and Spencer have provided us with guiding information on the basis of ability to see (visual acuity and contrast sensitivity) and visual comfort (blink rate). General rules in terms of brightness ratios have been formulated, it being recommended that the brightness ratio of the task to the surrounds should not be greater than three for "very good" seeing conditions.

The limitations of brightnesses of lighting fixtures have posed a more formidable problem. Many factors such as size, number, brightness and location of luminaires, work brightness, etc. must be evaluated. Stiles and Holladay have given us information for evaluating the disability effects of sources of brightness. However, the problem of comfort is of more immediate importance.

The earlier data of Nutting, Holladay and others provided some guides for lighting design, but unfortunately, they could not be extended without modification to typical current lighting systems. Over the years several methods have been proposed for evaluating glare values of typical lighting systems. However, more complete data are needed before we will be able to devise a universally applicable and completely suitable methods for evaluating discomfort. Work now going on in the laboratories of a number of researchers is paving the way toward a better understanding of the relative importance of the many factors which govern whether lighting systems are comfortable or uncomfortable.

Considerable work still remains to be done. Nevertheless, the available information indicates that we are moving in the right direction. These studies tell us how and to what extent we must control all brightnesses in order to provide comfortable visual environments.

Color

An important part of our Society's activities has been in the field of light and color. Colorimetry, spectral luminosity data, color of light sources, effects of typical sources on colored objects, colored surroundings and many other phases have been discussed at length in our journal. In fact, during the years, through its committees and individual members, the I.E.S. has stimulated a large share of the work that has been done on this important subject.

The development of fluorescent lamps and the limitless range of colors including the many lamps which provide so-called white light have raised new questions and created additional problems for study. Pleasantness of lighting involves many things and brings to the forefront the importance of color rendition, color effects, decoration, and shadow. Even where critical seeing is of paramount interest, colors of illuminants and objects and their interrelations cannot be ignored.

The Human Element

We all know that people are different. Their response to any stimulus, whether it be a prick from a pin or exposure to a glare source, will vary greatly. Practically all visual research data are presented in terms of averages which merely indicate how the *average* person will be expected to respond. People as individuals should, however, be

considered so that everyone can be given the opportunity for achieving a given visibility level, performance, ease of seeing, or degree of comfort.

Unfortunately, most tests involve only a few observers, so it is difficult to determine how individuals would respond or react. New data have been obtained on visibility and discomfort with relatively large groups of observers. In the case of visibility, it was found that about three times the average footcandle level is required in order that 95 per cent of the observers can achieve the visibility level indicated by the average.

Regarding brightness and comfort, similar results have been obtained. A brightness that is at the borderline between comfort and discomfort for the average person may be extremely uncomfortable for others. In fact, recent researchers indicate that luminaire brightnesses should be reduced to about 40 per cent of the average value to be comfortable for most of the observers.

Such analyses show the importance of obtaining data with larger numbers of observers. Furthermore, we should remember that many people have slightly subnormal vision. They, too, require more light for seeing.

I.E.S. Participation

Recognizing that research needs support by interested groups and organizations, the Society established in 1944 the I.E.S. Research Fund. This is an autonomous body which sponsors university research with the aim of establishing a sound basis for lighting techniques and the Society's recommended practices. These would supplement and complement the work that had been encouraged by the Society during all the preceding years.

During the past 10 years more than a score of investigations have been sponsored at over ten different universities. A few of the titles are indicative of the scope involved:

Muscle action potentials as a measure of visual performance.

An instrument for the evaluation of night vision on highways.

Visual brightness discrimination.

Studies of the contrast threshold — non-uniform surrounds.

Effect of a peripheral glare source upon the apparent brightness of an object.

Angular light reflectances of material used in offices, training quarters and ships.

Visual importance of spectral components of white light.

Effects of quality of illumination and color of background in color preferences.

A brightness-contrast threshold meter.

Indeed, research gives us answers and paves the way for better lighting in the future.

The Future

This brief summary of what has been studied by those interested in lighting research should indicate that we are making great forward strides in providing a sound basis for specifying light and lighting. Much has been accomplished, but more needs to be done. Improved light sources and lighting methods make higher footcandles economically possible, but lay new problems in our laps. Continued prodding by I.E.S. technical committees for more adequate data and stimulation by the Research Fund will, in the future, move us along slowly and steadily.

Seeing is a complex process. Its complexity should not be considered an insolvable problem, but a challenge. Research workers find it gratifying to see their results applied to the development of a sound lighting practice. This alone would be sufficient to encourage them to continue their work. The Illuminating Engineering Society has long been aware of its obligation and for fifty years has accepted the challenge and responsibility.

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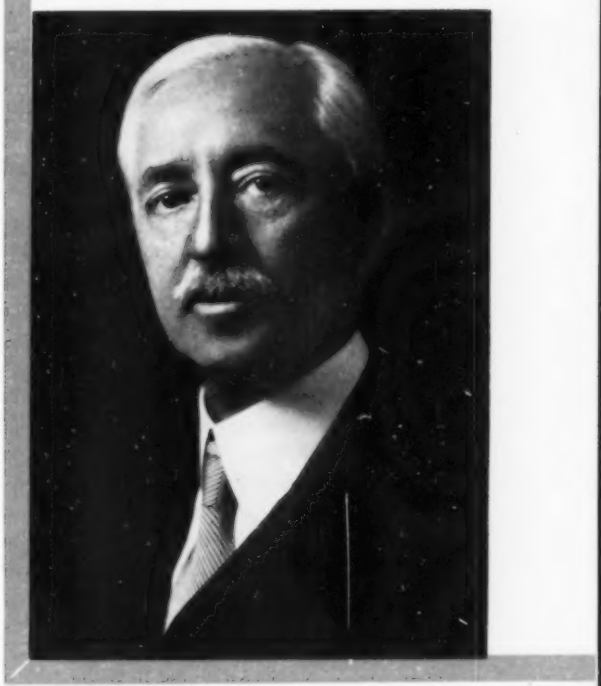

Louis B. Marks, President of the Illuminating Engineering Society, 1906

The Society's First Year

THIS IS HOW it began! On October 14, 1905, a young consulting electrical and lighting engineer, Mr. Louis B. Marks, wrote from his office at 202 Broadway, New York City, the following letter to his friend in the Holophane Glass Company. The letter which started it all, read as follows:

Mr. Van Rensselaer Lansingh
Holophane Glass Company
227 Fulton Street, City.
My dear Mr. Lansingh:

It has occurred to me that it might be a good idea to form a Society of Illuminating Engineers, with headquarters in this city. I believe that much good will result from a free exchange of ideas between those who are identified with this special branch of engineering.

Possibly we can arrange to take lunch together some day next week and talk this over. Call me up on the 'phone and we can make an appointment.

Very sincerely yours,
(signed) L. B. Marks

It was not strange that Louis Marks should write as he did, for his active mind was engaged in new problems of both man-made and natural light. While still an undergraduate student at Cornell University, he had applied for a patent on the enclosed carbon arc lamp, to greatly increase the burning life of the carbons. Later, in laboratories of the Westinghouse Electric & Manufacturing Company, he had commercially developed this illuminant. Undoubtedly with his cooperation, the scientific re-direction of the light was exemplified by the patenting, on April 14, 1900, of a prismatic glass globe for this lamp, by the Holophane Glass Company. It was logical that Mr. Marks should solicit the interest of his friend Lansingh, who held with him many a discussion on what constituted the scientific control of light.

A copy of Louis Marks' letter went to W. D'A. Ryan, at the Lynn Works of the General Electric Company. Mr. Ryan also became interested in some sort of association, to work along lines primarily of flaming and magnetite arc lamps, and the radial wave or similar reflectors for street lamps. In fact, D'Arcy Ryan became enthusiastic enough to join as a member of the original board of managers at the Society's organization.

Through these means, and by letters written by the persistent Mr. Marks to such men as Preston S. Millar, J. R. Cravath, Dr. Andre Blondel (Paris), Thomas A. Edison, and W. D. Weaver (Editor of *Electrical World*) there developed more sentiment in favor of the proposed organization than against it. But there was opposition! So, to crystallize the various thoughts, Mr. Marks on October 27, 1905, wrote Mr. Lansingh another letter, with this paragraph:

Prepared by Samuel G. Hibben, Chairman, I.E.S. Historical Committee.

"It seems to me that the best course to pursue would be for a number of us to get together at dinner some evening, as suggested at our last interview. Six or eight men, if they are the right ones, would do for a starter."

More than thirty were selected the next month as among "the right ones," and dinner plans proceeded. The stage was set for the premiere of the Illuminating Engineering Society.

Early Days and Influences

On the evening of a bright, clear day, December 21, 1905, as the sparkling arc and gas lamps did their part to suggest Christmas gaiety, a group of twenty-five business men, chiefly from New York City but also including several from neighboring cities, met at the Hotel Astor on Times Square, New York. Their purpose was to discuss a novel idea and to enjoy an excellent one-dollar dinner. This gathering was the result of the following invitation letter sent out over the signature of three young men, leaders of thought in the infant field of lighting. They grew later to be signally honored pioneers in that Fraternity. Their letter:

207 Fulton St.
December 15, 1905

Dear Sir:

It has been proposed to form a Society of Illuminating Engineers, composed of those people who are especially interested in the question of light and its distribution. For this purpose, the undersigned have asked a number of those most prominently interested in such questions to meet at the Hotel Astor, 44th Street and Broadway, this city, on Thursday evening, December 21, at 6:30 o'clock, to talk over the formation of such a Society and to discuss whatever is necessary to accomplish this purpose. We trust you will be able to attend this meeting and would ask that you kindly let Mr. L. B. Marks, 202 Broadway, New York City, know beforehand so that arrangements for an informal dinner may be made. The price of this dinner will be $1.00 each.

Trusting we may have the pleasure of meeting you at that time, we are,

Very truly yours,
(signed) L. B. Marks
E. Leavenworth Elliott
Van Rensselaer Lansingh

P. S. The dinner will be purely informal and business suits will be in order.

Some thirty persons had been invited. The high percentage of attendance (25) and the keen interest shown by those unable to attend was in itself convincing evidence that the subject of lighting was deemed worthy of consideration. In fact, several of these men had informally analyzed the problems of lighting practice on previous occasions. One place where the early seeds of interest had been sown through engineering discussions was in the New York office of the Holophane Glass Company (227 Fulton Street) since that company included in its personnel a high percentage of the young illumination engineers of that period; also since its commercial products, novel in those days, were being sold on the basis of rather exact scientific control and redirection of light. Another strongly leading influence was the arc lamp laboratory of the General Electric Company at Lynn, and still another the editorials and papers from the pen of Mr. E. Leavenworth Elliott, dynamic editor of the magazine *The Illuminating Engineer* (a private-enterprise publication).

Other influences had led up to the recognition of the need for lighting nomenclature and standards, not the least of which were the beginnings of commercial photometry and scientific sales promotion upon the part of manufacturers of coal gas, and of Welsbach mantles. Kerosene had lighted New York's residences since 1856; gas came to that city in 1864, and arc lamps on Fifth Avenue about 1879 — but cooperative engineering was scant!

Another factor, soon to become most influential was undoubtedly the embryo organization of licensed manufacturers of incandescent lamps, which later (in 1909) adopted the trademark "Mazda" and which led in 1912 to the licensing, under some General Electric and European patents, of coordinated lamp manufacturing. This group included the majority of large and small makers of incandescent lamp bulbs in the United States. It (The National Electric Lamp Association) was rapidly developing the needs and practices of photometry, soon to coordinate its light sources and the planned prismatic and silvered glass accessories; and before long, with such shock-cushioned chandeliers (for fragile tungsten filament lamps) as were then marketed under the name of "Tungstoliers" (The Conneaut Company, etc.).

Lighting thoughts were running through the minds of manufacturing executives who, for instance, gathered at the "Zoar Meeting" of October 14, 1904 in Astoria, Long Island. These were serious thoughts, even though a touch of humor was apparent. One item of entertainment in that early typical meeting was "Mademoiselle Gladys, in the dance of Aurora Borealis — a luminous meteoric phenomenon of electrical origin!"

Names later familiar within the lighting fraternity appear in these early records, such as: F. W. Bliss, E. L. Elliott, S. E. Doane, V. R. Lansingh, G. F. Norrison, J. R. Crouse, Franklin Overbagh, F. S. Terry, E. H. Haughton, and B. G. Tremaine.

The vision of these and several of their contemporaries, who saw the growing complexities of the

electric lighting business, guided an awakening industry to an altogether new evaluation of "cooperation" and "association." Furthermore, the scope of service offered by the older established technical societies, notably the A.I.E.E., did not cover matters of interest to the gas industry, which with the inclusion of kerosene and acetylene plus the rapidly growing use of Welsbach mantles, amounted to a substantial industry. Consequently, all signs pointed towards the logic of an association of lighting engineers. The time was ripe for the organization! Nationwide, there was a forward tide of exuberant growth and scientific renaissance. San Francisco was soon to rise anew after its great fire; new metals were discovered, some for lamp filaments; President Teddy Roosevelt waved the big stick of prosperity, and the name of Maude Adams in "Peter Pan," was outlined in carbon filament bulbs on Broadway. All this was a half century ago!

Organization and Name

At that first meeting at the Astor Hotel, the group was called to order by Mr. V. R. Lansingh. Mr. L. B. Marks was chosen temporary Chairman; Mr. E. L. Elliot, temporary Secretary.

It is significant that many prominent persons who were invited but prevented from attending were nevertheless prompted to write discussions on the matter. Correspondence of general approval came from Professor E. L. Nichols of Cornell, and C. P. Mathews of Purdue. Favorable comments were transmitted by Messrs. Dougherty and Woodwell of the U. S. Treasury Department, Washington; from Walter E. Boyd and John W. Lieb, Jr., of the New York Edison Company; from Albert Spies, Editor of *The Electrical Age*, and W. D. Weaver, Editor of *Electrical World and Engineer*. Mr. Weaver regretted that the new group would split away from A.I.E.E. but recognized the much more specialized scope of coverage that the new Society promised.

Mr. Lieb, in searching for a name, suggested an English equivalent of the German "Verein Fur Beleuchtungswesen." Evidently the members of this first group spoke freely and frankly on numerous phases of the organization, including its name and need. Mr. Wilcox urged that it be not exclusively electric. Mr. Ryan thought that "engineering" was frightening and that the proper name should be "Light Improvement Association." Dr. Sharp urged liaison with A.I.E.E., and Mr. Kellog admitted that architects believe there might be something virtuous in lighting science. Mr. Page stressed the needs of books and standards; Mr. Olcott suggested the title "Illuminating Society"; Mr. Mygatt discussed the question of how fixture manufacturers might profit; Mr. Pope, as a utility representative, regretted the wasteful usage of kilowatt-hours, and Mr. Howell called attention to the need of engineering in connection with electrical advertising.

Major Zalinski hoped that a new organization would discourage wastefulness and Mr. Millar thought that planned lighting had been too long neglected. Others ventured the thought that the science of illumination was destined to grow rapidly, and suggested the proper title be "Society for Economical Illumination." Mr. Elliott insisted that the word engineer or engineering would be appropriate in the title and finally Mr. Mygatt proposed the name "Illuminating Engineering Society." That was it, or so the Organization Committee wrote into the Constitution later.

At this first gathering, Mr. Elliott, then a scientist and editor, moved for the organization of a Committee of five people (changed by Howell's amendment to seven people) to undertake the crystallization of an organization, to report at a meeting place two weeks later. This Organization Committee consisted of the following: V. R. Lansingh, W. S. Howell, E. L. Elliott, W. D. Weaver, E. C. Brown, W. S. Kellogg, L. B. Marks (Chairman).

The New York Edison Company offered its meeting hall at 44 West 27th Street for the next gathering, and in the meantime Mr. Lansingh was to assemble a prospective list of persons to be invited. Thus, stone by stone — ideas fitted to ideas — the foundation was laid.

First Official Meeting of I.E.S.

On January 10, 1906, again at the Hotel Astor at an evening meeting, a considerable number of persons gathered and adopted the name of the Society as well as the first Constitution and By-Laws. Characteristically, these were models of clarity, simplicity, and directness. W. D. Weaver is said to have prepared most of that original Constitution. There was established one class of membership; the annual dues of five dollars, and a Headquarters organization essentially as it exists today. The first President was L. B. Marks; the first two Vice-Presidents were Messrs. A. A. Pope and C. H. Sharp. A. H. Elliott was the first Secretary, and V. R. Lansingh was the first Treasurer. Composing the first Board of Managers were Messrs. W. D. Weaver, E. L. Elliott, W. S. Kellogg, E. C. Brown, F. N. Olcott, and W. D'A. Ryan.

At that time the leading lighting publication was

The Illuminating Engineer. E. L. Elliott was its tireless editor, first at No. 12 West 40th Street, New York, and later operating from the Broad-Exchange Building, 25 Broad Street, New York City. At the subscription price of ten cents a copy, or one dollar annually, this really outstanding magazine recorded the facts of interest in the early days of lighting, and later drew most of its material from the papers presented before the newly established I.E.S. (Later the editor of *Illuminating Engineer* was Norman MacBeth and still later, A. J. Marshall.) Concurrently, with the issue in February 1906 of Vol. I, No. 1 of the *Transactions of the Illuminating Engineering Society*, this latter publication became the official public record of Society affairs.

Commenting in his own magazine, in the March 1906 issue, Mr. Elliott spoke of the new Society as follows:

> The most significant sign of the times, bearing upon the recognition of illumination as an engineering problem, is the formation of the Illuminating Engineering Society, which was consummated on the 10th of January, this city. . . . The general readiness, amounting in most cases to actual enthusiasm, on the part of the leading representatives of the various interests concerned with problems of illumination, furnished proof that this movement falls in an auspicious time, and assures for the Society a rapid growth to such a position of importance as will place it among the old established technical societies of this country.

Once having established the Society's structure and with a growing list of membership, the real business of the I.E.S. began. Most of the prominent men in illumination had promptly joined its membership, including Thomas A. Edison and André Blondel. (See reference section for list of Charter Members of I.E.S., *i.e.*, members joining before the third meeting.) Mr. George H. Guy was installed for six months as a Corresponding (paid) Secretary, and regular meetings of the New York group began. By 1907, permanent headquarters offices were rented at the Engineering Societies' Bldg., 33 West 39th Street, New York.

One of the first meetings of importance was on February 13, 1906, at the Hotel Astor. It was noteworthy for the scholarly and surprisingly prophetic inaugural address of President Marks. He mentioned that some 150 members were now enrolled and that the organization had all the promises of a healthy future. The address stressed the importance of shaded rather than raw light and that the eye would profit from better care. "Was glare necessary?" he asked! Street lighting was emphasized as far too meager for the promised motor vehicle. How prophetically true! He stated there were needs for better ratings of illuminants; more exact standards, and better methods of judging quality of illumination.

He spoke of close liaison with the American Gas Light Association because the gas interests together with oil illuminants had an almost equal financial stake in lighting, as did the electrical interests. In a breakdown of this subject, it was recorded that the annual business volume estimated in 1905-1906 was about as follows:

Electric Light	$100,000,000 to	$120,000,000
Coal and Water Gas	35,000,000 to	40,000,000
Natural Gas	1,700,000 to	2,000,000
Acetylene	2,500,000 to	3,000,000
Oil	60,000,000 to	75,000,000

It was pointed out in this address that shortly before the establishment of the Society, the electric utilities' income in the U. S. totaled some twenty-five and a half million dollars from arc lighting, and forty-four and a half million dollars from incandescent lighting. It was thought that about 420,000 arc lamps were in service compared to about 18,200,000 incandescent bulbs. The total sale of incandescent filament lamps in 1905 was about 45,000,000 units, of which about 70 per cent were 16 candlepower (approximately 40 watts, 155 lumens) carbon filament lamps; 7 per cent were larger than 16 candlepower and about 23 per cent smaller than 16 candlepower. (Note that the "International Candle" was not established until later, and the term "lumen" was not in commercial use.)

The February 14, 1906 issue of the *New York Times* reported on this Presidential address with considerable emphasis and favor. The burden of the press comments seemed to be that at last an organization was functioning which primarily had the *consumer's best interests as a prime objective!*

At this same February 13 meeting, the three first general papers scheduled for the next meeting were:

Luminous Arc Lamps — E. L. Elliott.
Inverted Gas Burners — Victor Rettich.
Illuminating Engineering from the Architect's Standpoint — W. S. Kellogg.

Throughout the discussions of basically important pioneering papers presented in those early days there often ran a strong warp of thought concerning economics, since these were the years when rapid changes were occurring in efficiencies of light sources. Milestones of memory along the avenues of progress were such as the costs of lighting with sperm oil at $2.25 per gallon; the 50-cent kerosene and of "refined petroleum" at 5 cents per gallon. Before the days of tungsten filament illuminants there were discussions of the 700-hour two-

Group photographed at Nantasket Point Hotel, July 31, 1907, during the First Annual Convention of the Illuminating Engineering Society.

watts-per-candle tantalum lamps priced at $1.00 each, and there were many reported studies of arc lamp developments by Bremer-Blondel, Marks, Steinmetz, and of the luminous and magnetite arcs with efficiencies on the order of one-quarter watt per maximum candle. Increases with acetylene lighting were sometimes discussed. Mercury arcs were given but little hope.

A good idea of the authors and subject of papers can be gathered from a typical list taken from the records of that first year of the I.E.S. meetings:

Magnetite Arcs, W. S. Barstowe.
Hygienic Effects of Lighting by Gas, A. P. Beardsley.
Physiological Factors in Illumination, Dr. Louis Bell.
Residence Lighting, J. R. Cravath.
Color Phenomena, J. S. Dow.
The Year's Progress, E. L. Elliott.
Lighting of Department Stores, F. M. Feiker.
Use of Acetylene, Sir C. S. Forbes.
Needs for Engineers, Leon Gaster.
Lamp Photometry, Hyde-Cady.
Hospital Lighting, W. S. Kilmer.
Principles and Applications, V. R. Lansingh.
Meters and Uses, Norman Macbeth.
The Flame Carbon Arc, L. B. Marks.
Lamp Life, P. S. Millar.
Fluorescence & Phosphorescence, E. L. Nichols.
High Voltage Glow Lamps, C. C. Paterson.
Gas Illumination, R. M. Searle.
New Types of Lamps, C. H. Sharp.
Lighting and Illumination, C. P. Steinmetz.
Errors in Photometry, A. P. Trotter.
Lighting of Streets by Gas, F. V. Westermaier.

The Emblem

Not long after the acceptance of the I.E.S. Constitution, came the need for an official Society monogram or emblem. This task was undertaken and completed by Waldo S. Kellogg, a director in 1906. The drafting work was done in the office of Carrere and Hastings, well-known architects at 28 East 41st Street, New York City. Mr. Kellogg's design consisted of a gold shield with a blue field on which in gold was carried the three initials I.E.S., and the burning lamp of learning. Flanking this were three small decorative torch ornaments. The background of the shield was a winged flaming torch in gold. The design was adopted in June 1906, and has remained unchanged to this day. (Much later the blue field was reserved for full Members; a red field for Associate Members, and a white field for Fellows.)

Forming of Sections

It was in Boston, at the American House, that a local group met on March 20th, 1906, electing John Campbell as Chairman, to form the first (New England) Section. In that busy year of 1906, on June 8th, there was established from the nucleus group, the New York Section, comprising about 50 local members. First Chairman was A. E. Forstall; two Vice-Chairmen, namely, Frank A. Pattison, and Dr. F. Schniewing; Secretary, P. S. Millar.

This New York group, though it had been meeting for some six months, was not named as a "Section" until late in 1906, since it was looked upon as the home unit. A Section in Chicago preceded this by a month, their establishment being on May 7, 1906. Mr. J. R. Cravath, now in California, still an active member of I.E.S., will be remembered among the stalwarts in that region. Leo Dolkart, another Charter Member, is also still a working member of the Chicago Section.

These Sections were soon followed by the formation of a Pittsburgh Section on September 12, 1906, and the Philadelphia Section about September 14, 1906. Other Sections soon followed, since the matters of Society meetings and most of the papers operations were carried on by the Sections. The Headquarters staff was generally the Assistant Secretary, and a stenographer. The Executive Officers were business men, cheerfully contributing — then as now — some parts of their time to the task.

Thus 1906, when our fathers began seriously to consider automobiles, aircraft, naval supremacy — and good lighting — was a fruitful year. The Illuminating Engineering Society was created to meet the needs and advance the dissemination of knowledge of a new science and an awakening art. As these have exuberantly expanded, so has the Society.

By the beginning of 1907, I.E.S. had over 815 members. It held its first annual meeting January 14, 1907 at the Electric Club, 14 Park Place, New York City, where its second president, Dr. C. H. Sharp, took charge of a vigorous and solvent Society.

First Convention

In the summer of 1907, on July 30 and 31, the first general Convention of the I.E.S. was held at the Edison Building in Boston. President Sharp was in the chair, with J. S. Codman serving as Convention Chairman. Attendance was 200. A banquet was part of its program, a brilliant social affair, held at the Nantasket Point Hotel.

Total membership of the growing young organization was now 1047. Happily, records of this and subsequent Conventions, together with complete bound volumes of all Minutes, Proceedings and Transactions of the I.E.S. are maintained at the present headquarters office at 1860 Broadway, New York, N. Y. These records are rich with its history, not only of growth, but of increase of its stature and service to its avowed aim, "...the advancement of the theory and practice of iluminating engineering and the dissemination of knowledge relating thereto."

National Technical Conferences of the Illuminating Engineering Society

Year	City	Attendance
1907	Boston, Mass.	200
1908	Philadelphia, Pa.	400
1909	New York, N. Y.	No record
1910	Baltimore, Md.	244
1911	Chicago, Ill.	No record
1912	Niagara Falls, N. Y.	162
1913	Pittsburgh, Pa.	459
1914	Cleveland, Ohio	300
1915	Washington, D. C.	350
1916	Philadelphia, Pa.	450
1917	Correspondence Convention	—
1918	New York, N. Y.	No record
1919	Chicago, Ill.	No record
1920	Cleveland, Ohio	No record
1921	Rochester, N. Y.	159
1922	Swampscott, Mass.	309
1923	Lake George, N. Y.	269
1924	Briarcliff, N. Y.	362
1925	Detroit, Mich.	376
1926	Spring Lake, N. J.	337
1927	Chicago, Ill.	489
1928	Toronto, Ont., Canada	552
1929	Philadelphia, Pa.	745
1930	Richmond, Va.	476
1931	Pittsburgh, Pa.	514
1932	Swampscott, Mass.	258
1933	Lake Delavan, Wis.	440
1934	Baltimore, Md.	370
1935	Cincinnati, Ohio	514
1936	Buffalo, N. Y.	639
1937	White Sulphur Springs, W. Va.	462
1938	Minneapolis, Minn.	641
1939	San Francisco, Calif.	411
1940	Spring Lake, N. J.	611
1941	Atlanta, Ga.	573
1942	St. Louis, Mo.	516
1943	New York, N. Y. (1-day Meet.)	126
1944	Chicago, Ill.	721
1945	———	—
1946	Quebec, Que.	807
1947	New Orleans, La.	605
1948	Boston, Mass.	906
1949	French Lick, Ind.	668
1950	Pasadena, Calif.	556
1951	Washington, D. C.	765
1952	Chicago, Ill.	859
1953	New York, N. Y.	1007
1954	Atlantic City, N. J.	851
1955	Cleveland, Ohio	754
1956	Boston, Mass.	

FOR THE RECORD

Charter Members of I.E.S.

(Joined during First Three Months of 1906)

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I.E.S. Presidents, 1906-1956

L. B. MARKS, 1906
CLAYTON H. SHARP, 1907
LOUIS BELL, 1908
WM. H. GARTLEY, 1909
E. P. HYDE, 1910
A. E. KENNELLY, 1911
V. R. LANSINGH, 1912
PRESTON S. MILLAR, 1913
CHARLES O. BOND, 1914
A. S. MCALLISTER, 1914-1915
CHARLES P. STEINMETZ, 1915-1916
WILLIAM J. SERRILL, 1916-1917
G. H. STICKNEY, 1917-1918
GEORGE A. HOADLEY, 1918-1919
S. E. DOANE, 1919-1920
GEORGE H. HARRIES, 1920-1921
GEORGE S. CRAMPTON, 1921-1922
WARD HARRISON, 1922-1923
C. L. LAW, 1923-1924
E. C. CRITTENDEN, 1924-1925
M. LUCKIESH, 1925-1926
H. H. HIGBIE, 1926-1927
NORMAN MACBETH, 1927-1928
M. C. HUSE, 1928-1929
H. H. MAGDSICK, 1929-1930
W. F. LITTLE, 1930-1931
JULIUS DANIELS, 1931-1932
J. W. BARKER, 1932-1933
J. L. STAIR, 1933-1934
A. L. POWELL, 1934-1935
L. A. S. WOOD, 1935-1936
G. B. REGAR, 1936-1937
H. B. DATES, 1937-1938
D. W. ATWATER, 1938-1939
L. H. GRAVES, 1939-1940
A. D. CAMERON, 1940-1941
WILLARD BROWN, 1941-1942
R. B. BROWN, JR., 1942-1943
HOWARD M. SHARP, 1943-1944
S. B. WILLIAMS, 1944-1945
A. F. WAKEFIELD, 1945-1946
G. K. HARDACRE, 1946-1947
R. W. STAUD, 1947-1948
L. E. TAYLER, 1948-1949
C. H. GODDARD, 1949-1950
WALTER STUBROCK, 1950-1951
S. G. HIBBEN, 1951-1952
E. M. STRONG, 1952-1953
A. H. MANWARING, 1953-1954
D. M. JONES, 1954-1955
R. F. HARTENSTEIN, 1955-1956

Sections and Chapters of I.E.S.

	Name	Chapter Chartered
1.	NEW ENGLAND SECTION	Apr. 1906
2.	CHICAGO SECTION	May 1906
3.	NEW YORK SECTION	Jun. 1906
4.	PHILADELPHIA SECTION	Sept. 1906
5.	PITTSBURGH SECTION	Sept. 1906
6.	GOLDEN GATE SECTION (Chartered as Northern California Chapter)	Jun. 1920
7.	CLEVELAND SECTION	Jan. 1921
8.	TORONTO SECTION	Mar. 1921
9.	MICHIGAN SECTION	May 1923
10.	SOUTHERN CALIFORNIA SECTION	Jul. 1923
11.	SOUTHWESTERN SECTION	Dec. 1925
12.	CAPITAL SECTION (Chartered as Baltimore-Washington Chapter)	Feb. 1927
13.	MARYLAND SECTION (Chartered as Baltimore-Washington Chapter)	Feb. 1927
14.	WESTERN NEW YORK SECTION	Sept. 1928
15.	OHIO VALLEY SECTION	May 1934
16.	MONTREAL SECTION	Sept. 1935
17.	TWIN CITY SECTION	Apr. 1937
18.	ST. LOUIS SECTION (Chartered as Spirit of St. Louis Chapter)	Aug. 1937
19.	HEART OF AMERICA SECTION	Oct. 1937
20.	IOWA SECTION (Chartered as Nebraska-Iowa Chapter)	May 1938
21.	GEORGIA SECTION	Aug. 1939
22.	NEW ORLEANS SECTION	Mar. 1940
23.	INLAND EMPIRE CHAPTER (Chartered as Washington State Chapter)	Oct. 1940
24.	PUGET SOUND SECTION (Chartered as Washington State Chapter)	Oct. 1940
25.	OREGON SECTION	Jan. 1941
26.	CONNECTICUT SECTION	Feb. 1941
27.	ROCKY MOUNTAIN SECTION	Jul. 1941
28.	INDIANA SECTION	May 1944
29.	CENTRAL NEW YORK SECTION	Jun. 1944
30.	OTTAWA CHAPTER	Oct. 1944
31.	SAN JACINTO SECTION (Chartered as South Texas Chapter)	Jun. 1945
32.	BRITISH COLUMBIA SECTION	Sept. 1945
33.	MILWAUKEE SECTION	Feb. 1946
34.	ROCHESTER SECTION	Jun. 1946
35.	UTAH SECTION	Apr. 1947
36.	ALAMO CHAPTER	Jun. 1947
37.	CORNHUSKER CHAPTER	Jun. 1947
38.	EASTERN PENNSYLVANIA SECTION	Jun. 1947
39.	FLORIDA SECTION	Dec. 1947
40.	HAMILTON ONTARIO CHAPTER	Apr. 1948
41.	MOTHER LODE CHAPTER	Jul. 1948
42.	TAR HEEL SECTION (Chartered as Carolinas Chapter)	Feb. 1949
43.	TENNESSEE VALLEY SECTION	Feb. 1949
44.	MARITIME CHAPTER	Apr. 1949
45.	SOUTHEAST FLORIDA CHAPTER	Jun. 1949
46.	QUEBEC CHAPTER	Jun. 1949
47.	WINNIPEG CHAPTER	Jun. 1949
48.	WESTERN MICHIGAN CHAPTER	Dec. 1949
49.	MISSISSIPPI CHAPTER	Apr. 1950
50.	NORTHEAST OHIO CHAPTER	Jun. 1950
51.	MEXICO CHAPTER	Jul. 1950
52.	ARIZONA SECTION	Oct. 1951
53.	OIL CAPITAL SECTION (Chartered as Oklahoma Chapter)	Dec. 1951
54.	CENTRAL ILLINOIS CHAPTER	Mar. 1952
55.	NEW MEXICO CHAPTER	Jun. 1952
56.	SOUTHERN COLORADO CHAPTER	Jun. 1952
57.	EASTERN NEW YORK SECTION	Jun. 1952
58.	TWIN PORTS CHAPTER	Oct. 1952
59.	VANCOUVER ISLAND CHAPTER	Oct. 1952
60.	MID-SOUTH CHAPTER	Oct. 1952
61.	SAN JOSE CHAPTER	Oct. 1952
62.	ALABAMA CHAPTER	Feb. 1953
63.	SAN DIEGO CHAPTER	Jul. 1953
64.	ARK-LA-TEX CHAPTER	Feb. 1954
65.	VIRGINIA CHAPTER (Chartered Sept. 1930—Disbanded Jun. 1936)	Apr. 1954
66.	MIAMI VALLEY CHAPTER	Jun. 1954
67.	PALMETTO CHAPTER	Jun. 1954
68.	ARKANSAS CHAPTER	Jun. 1954
69.	CENTRAL OKLAHOMA CHAPTER	Dec. 1954
70.	SUWANNEE RIVER CHAPTER	Mar. 1955
71.	BLUENOSE CHAPTER	Jul. 1955
72.	PANHANDLE CHAPTER	Oct. 1955

Looking Ahead

The Editor wishes this commemorative issue, embodying so much history, to close with an opinion about the future. After all, the present is always a program of possibilities generated by the past. Our record since 1906, represented by the reports in this issue, shows our past has been the basis for constantly broadening hopes. What should we expect in the years ahead? What must we do to fulfill our destiny? We asked a distinguished Past President to offer the answers to these questions. He has done this in the form of a colloquy between himself and a chronicler of the profession . . . for many years "publisher" of the Magazine of Light, which became famous during his editorship.

WILLARD BROWN: When I decided to go into the lighting business 40 years ago, my youthful reasoning concluded that the electric lamp was the most inefficient of all electrical devices. Actually, it was about ten per cent of maximum theoretical efficiency. It seemed to me then, that working with that sort of tool one was bound to be in on an absorbing chapter of progress. I wanted to identify myself with that development process inviting participation in great advance for all mankind. My expectations have been fulfilled to overflowing.

I have seen a three-fold increase in the efficiency of light sources! Nevertheless, we are still only a third of the way up the ladder towards the theoretical maximum efficiency. It seems to me we can confidently write in large letters:

A VERY BRIGHT FUTURE LIES AHEAD FOR THE NEXT GENERATION OF LIGHTING MEN AND WOMEN.

Let's put this prediction in historical context, Mr. Tugman.

J. L. TUGMAN: Our 50th Anniversary comes at a time of great opportunity. By even the most conservative estimates business activity is entering a period of immense promise. Prosperity seems destined to climb to heights we can only imagine. Even the most restrained views of lighting's share in the next decade expect it to be double the present consumption. Considering the fact that our present rate is four times the use in 1940, it appears that a magnificent past is to be dwarfed by a future that is just a bit awesome. The lighting *business*, by all counts is going places, because it will be doing things.

The membership of the IES, however, faces a new and different situation, without precedent in our past. Hitherto, we have had the technically trained manpower to provide the leadership that has helped our lusty industry to orient its energies. We have shown it how to serve the public responsibility, and we have established canons of practice which give lighting its present readiness to move forward.

What about the outlook for *science* and *art* of lighting? Where is this tremendous updraft of accelerating business activity taking our profession?

MR. BROWN: The crux of the problem of the immediate future certainly seems to be development of people rather than things. Things themselves are so vibrant with possibilities for creative lighting men that any capable aspirant should be able to carve out a fine career. Just look —

Large luminous areas are now contemplated. Perhaps the next step will be self-luminous areas. If one wants to dream, why not go further? Luminous air — a sort of fairy cloud, if you will, lighting every nook and corner of the work below, activated with some sort of radiation from a central source of power. Far-fetched . . . certainly . . . but in crude form we can even today demonstrate one sort of result of this kind.

Quantities of light — well, if we get the researchers we need, they will point the way in terms the public can understand. And in the span of a short 50 years we have moved from the time of serious argument as to whether 1.4 or 1.5 footcandles were best, up to the almost commonplace 100-footcandle installations of today. Certainly much lies ahead here too. Not too far ahead are levels of lighting that will bring working places to the brightnesses we enjoy in the shade of a tree or on a shady porch in the summertime. Five times the good lighting of today! Yes, there is much ahead in the way of quantity too.

MR. TUGMAN: In developing our fine 50-year record we must confess we have not achieved such mastery of practice that most installations at any time would represent the Society's standards. People are free to choose sub-standard work, and they do, all too frequently. They probably will do so in the future. In this connection we may take some consolation from the influence of some older professions. People still doctor themselves to an extent that makes physicians shudder. And, of course, a good many people take the risk of being their own lawyers.

We won't even paraphrase the lawyer's maxim that, "He who has himself for his lawyer has a fool for a client."

There has never been a time in our 50 years when we have had enough fully qualified illuminating engineers to give the kind of professional counsel that has been needed. We have had to recruit men and women without technical training to work with us. We have had to cultivate other professions with interests in our field.

MR. BROWN: With our professional allies and our non-technical recruits, however, we have managed to make our influence a real leadership. Thus, with a small corps of researchers, who developed and improved basic concepts, and a slightly larger group of specialists, who took these concepts to the field and made them work, we have made the genius of the few go a long way.

Our real problems in the years immediately ahead are truly formidable. If resources permitted we should be training a much larger group of researchers and specialists. Illumination courses in the technical schools should be expanded for a greatly increased enrollment. Each year we should be expanding the central corps of our profession with men equipped to carry on the brilliant work of the recent past.

MR. TUGMAN: Lamentably, evidence indicates, these are *not* the things we are doing to meet the great opportunities coming up right now. We are not going to have enough new engineers to provide replacements for those who are retiring or going into administrative work. We are not going to get much time on the curriculums of the technical schools, hard pressed to equip a sadly short supply of engineers.

As we face our periods of greatest opportunity with an actual decline in specifically trained personnel we must turn more than ever to reliance on non-technical recruits. These, and our allies in other professions must carry on the work so well begun. What does this mean as we enter our next half century of professional life?

MR. BROWN: It seems to me this means hard concentration on training programs and refresher courses. If we must provide leadership, based on a sound knowledge, we shall have to work intensively on the quality of membership. We must develop more artists and salesmen and decorators who can take up one or another of the fields of lighting specialization. We must bring more women into the service of our profession. One day we shall discover that careers for women in lighting will be offering an important and profitable target for feminine aesthetic judgment.

Architects and decorators and management consultants must be cultivated more effectively in the future. They are going to be deciding a great many things that will determine the character of lighting development. We must exert ourselves to see that they make their decisions with the benefit of our special knowledge.

If we present our information with the confidence it deserves we shall help the vast investment going into the nation's future to have its seeing facilities economically coordinated with other technological facilities. It would be a tragic disservice to the economy and the community if we permit lighting to fall behind the pace of progress for lack of personnel to provide good counsel.

The first fruitful step to take, it seems to me, is to give more genuine appeal to local IES meetings. Our profession is not alone in the problem of making association in meetings attractive and fruitful. Manifestly, I believe, our profession must make these occasions bright and sparkling. They must convey the idea that our concern is not simply that the lighting business is good, but that it is good because we have given it scope and dimensions by our leadership.

MR. TUGMAN: The health and wealth of the nation are among our professional concerns. Fruitful human activity begins with seeing our way to do things. The clearer we see what we want to do the more effectively we create wealth. The promise and challenge of the future is that we shall have more time to develop our capacities as humans more fully. The science of lighting, which has multiplied our ranging sense of sight, by giving it a better working tool than daylight, can help us realize the promise of the future.

MR. BROWN: Our job is to avoid self congratulation because the lighting *business* is bound to be good. Our job is to keep standards advancing relevantly to advancing needs. Our job is to dare to think in terms appropriate to our task. We must shape our opportunity to our own design.

Where Credit Is Due

No by-lines have been included with the material presented in this issue. Many of the sections represent the work of "teams," in some cases as many as fifty contributing. Specific credit is due as follows, however, for the preparation of the various sections:

LAMP MAKERS' STORY

Charles E. Weitz, and Gwilym F. Prideaux, General Electric Company, Nela Park, Cleveland, Ohio.

Eugene W. Beggs, Westinghouse Electric Corporation, Bloomfield, N. J.

Dr. E. W. Lowry, Sylvania Electric Products Inc., Salem, Mass.

EQUIPMENT

J. L. Stair, 1734 East 72nd St., Chicago, Ill.

EXPOSITIONS

C. M. Cutler, General Electric Company, Nela Park, Cleveland, Ohio.

SCHOOL LIGHTING

T. D. Wakefield, Wakefield Company, Vermilion, Ohio.

C. J. Allen and J. M. Ketch, General Electric Company, Nela Park, Cleveland, Ohio.

Willard Allphin, Sylvania Electric Products Inc., Salem, Mass.

Deac Martin, Unique Services Inc., Cleveland, Ohio.

Leonard V. James, 513 S. Catherine St., La Grange, Ill.

INDUSTRIAL LIGHTING

George J. Taylor, Day-Brite Lighting Inc., New York, N. Y.

E. A. Linsday and Anson H. Russell, General Electric Company, Nela Park, Cleveland, Ohio.

Kurt Franck, Holophane Company, Inc., Newark, Ohio.

W. P. Lowell, Sylvania Electric Products Inc., Salem, Mass.

W. H. Kahler, Westinghouse Electric Corp., Cleveland, Ohio.

STORE LIGHTING

R. T. Dorsey, General Electric Company, Nela Park, Cleveland, Ohio.

R. C. Allison, T. Eaton Company, Toronto, Ontario

Kenneth C. Welch, 924 Grandville, S. W., Grand Rapids, Michigan.

OFFICE LIGHTING

R. L. Oetting, General Electric Company, Nela Park, Cleveland, Ohio.

J. J. Neidhart, Westinghouse Electric Corp., Cleveland, Ohio.

STREET LIGHTING

I.E.S. Committee on Street and Highway Lighting, with assistance and appraisal from numerous others; George E. Korten, Consumers Power Company, Jackson, Michigan, serving as team coordinator.

RESIDENCE LIGHTING

E. W. Commery, General Electric Company, Nela Park, Cleveland, Ohio. (Photos for Fig. 1, courtesy of Miss Myrtle Fahsbender, Westinghouse Electric Corp., Bloomfield, N. J.)

PUBLIC BUILDINGS

Edward Rambusch, Rambusch Lighting Inc., New York, N. Y.

STAGE LIGHTING

Stanley McCandless, Century Lighting Inc., New York, N. Y.

Joel E. Rubin and Herbert A. Kleigl, Kleigl Bros., New York, N. Y.

DAYLIGHTING

R. W. McKinley, Pittsburgh Plate Glass Company, Pittsburgh, Pennsylvania, with appraisal from 1954-1955 I.E.S. Committee on Daylighting.

AUTOMOTIVE

Val J. Roper, General Electric Company, Nela Park, Cleveland, Ohio.

FARM AND PLANT LIGHTING

Joseph P. Ditchman, General Electric Company, Nela Park, Cleveland, Ohio.

RESEARCH

Sylvester K. Guth, General Electric Company, Nela Park, Cleveland, Ohio.

I.E.S. HISTORY

Samuel G. Hibben, Montclair, N. J., and I.E.S. Historical Committee.

Fiftieth Anniversary Issue

BACKWARD GLIMPSES toward where you've been, from where you are, seem irresistible on reaching any pinnacle. And fifty years is a significant pinnacle. To commemorate the Society's fiftieth birthday, this issue of ILLUMINATING ENGINEERING takes a "look over its shoulder" you might say, to review some of the highlights in lighting development over the years.

Not all of the phases of lighting application and illumination developments are represented — but they will be, before the Anniversary Year is out, appearing from time to time in later 1956 issues. There is a fascinating story to tell of Photometry — the Measurement of Light. This will be told in an early issue. Outdoor Lighting in all of its ramifications is another interesting phase of lighting. The important field of Transportation, including lighting for trains, buses, airplanes, ships and subway cars, will get into the record during 1956. So will Signal Lighting and its great developments, and lighting for Television production, lighting for surgery, the history of Trade Associations in the lighting industry, and several others. The bound volume of ILLUMINATING ENGINEERING for 1956 it is hoped will furnish a vast "Progress Report" on lighting during the Society's first fifty years.

Contributors to this issue, and to those sections still to come, have had in mind two things: The natural curiosity and interest of contemporaries in developments which might be considered significant milestones in their profession; and the summing up of highlights at the half-way period for its reference value fifty years hence. The issue of the Society's journal which will commemorate the I.E.S. Centennial in the year 2006 will be prepared by an editor as yet unborn, or currently in his playpen. He will no doubt be grateful to the men who undertook months of research, months of work, in the preparation of the fifty-year summary. As, indeed, is the present editor! — and all of the Society.

Oldtimers may recall developments which are not mentioned — or which do not receive the emphasis they feel is deserved. The Editor foresaw this possibility, from the start. None of the sections is represented as being an "all-time reference" on the subject covered. At the same time, however, sincere effort has been made to present a meaningful outline of significant developments, having current interest, and reference value as well. Data for many of the sections have been contributed by "teams" made up of lighting experts from many companies, from all parts of the country. For the benefit of illuminating engineers of the future, it might be said that this presentation represents a cross-section of current opinion on what was significant in lighting development in the Society's first fifty years.

Ruby Redford

EDITOR

Here and There with I.E.S. Members

Miss Myrtle Fahsbender, Director of Residential Lighting, Westinghouse Lamp Division, was one of the featured guest speakers at the November 9 meeting of the Philadelphia Section. She discussed residential and garden lighting equipment, with a live garden built into the stage. The other speaker on the program was H. H. Watson, Commercial Engineer for General Electric, who spoke on "Modern Wiring — the Key to Complete Electric Living." Attendance was 150, including some from garden clubs in the area.

Three speakers and a Program Chairman — at the November 8th meeting of the Michigan Section, I.E.S. Left to right: Thomas J. Peterson, Detroit Edison Co., who spoke on how utilities assist in the promotion and advancement of better lighting; A. F. Wakefield, The Wakefield Co., who presented "The Relationship of Trade Associations and the Professional Society"; John Wright, Curtis Lighting, Inc., whose topic was "Coordination of the Lighting Market Development Programs"; and Herbert Cook, Program Chairman.

Certificate of I.E.S. Fellow is presented to Charles D. Gibson, left, by Southern California Section Chairman Roy Kreyser. The ceremony was conducted at the Section's November 2 meeting.

First copy off the press — of the Proceedings of the Street Tree and Utility Conference — is presented to R. F. Hartenstein, President of I.E.S., by Kirk Reid, Junior Vice-President of the Society and one of the three co-chairmen of the Conference last March. Left to right in the photograph: standing, Kirk M. Reid; A. D. Hinckley, Executive Secretary; J. S. Schuchert, I.E.S. Treasurer; C. L. Crouch, Technical Director. Seated, Marshall Waterman, Senior Vice-President, and Mr. Hartenstein. Presentation of the book was made at the November 16 meeting of the Council Executive Committee in Akron, Ohio.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

December Council Meeting, New York City, Summary of Action Taken

The Council of the I.E.S. met December 8, 1955 at the Lexington Hotel in New York City, with 29 members and guests present. R. F. Hartenstein, President of I.E.S., presided.

In addition to regular business of the Society, review of finances, etc., a number of new assignments to committees were approved. Complete up-to-date list of Committee personnel will be published in the April issue of I.E.

Membership Statistics

General Board of Examiners reported their election of 64 Associate Members and 4 Students, and recommended favorable action on the election and/or reinstatement of 18 Members. They also recommended a transfer from Member to Member Emeritus Grade for Miss Caroline E. Horn of Ridgefield, Conn., the first woman to be so honored. Favorable action on the Board's report together with other membership changes, brought the membership figures to those shown in the following tabulation:

November 16, 1955		December 8, 1955
8279	Total Membership	8298
35	Members Emeritus	36*
89	Fellows	89
1998	Members	2006
5955	Associate Members	5953
202	Student Members	204

*Includes 12 Fellows.

Golden Anniversary

Richard G. Slauer, Chairman of the Special Task Committee to formulate plans for the Society's Golden Anniversary, reported to Council a number of activities underway in some 35 Sections and Chapters, for Anniversary celebrations. Mr. Slauer noted that the Committee, appointed at the October Council meeting, was working closely with the Sections and Chapters on specific Anniversary programs. Working with him in this activity are: Berlon Cooper, Julius Daniels, Samuel Hibben and Kirk Reid.

Some of the Golden Anniversary plans, he outlined included:

(1) A special Anniversary Meeting to be held in each Section and Chapter sometime during the year between January 1 and September 15, preferably on January 10, the Society's "birthday." An alternative date could be the anniversary of the Section or Chapter's charter.

(2) At this meeting, a talk by a member of Council would be a feature of the program, giving a twenty- to thirty-minute review of the Society's progress over fifty years.

(3) Part of the local Anniversary meeting celebration would include a birthday cake, topped by a large golden candle, to be cut and distributed. Within the cake, or as a door prize, would be special Anniversary pins, to be worn regularly by the winners. In each Section and Chapter, the Anniversary "representative," winner of the pin, would be encouraged to take part in further ceremonies in connection with it, to be held at the Boston Convention. Failing this, a proxy would wear the pin at Boston, where the Conference Committee will have several special features involving the 72 "official birthday ambassadors."

Mr. Slauer outlined a number of plans to be carried out in cooperation with the Public Relations and Information Committee and the Boston Conference Committee, both working closely with the special Anniversary Task Committee.

Council congratulated the Task Committee on the program presented, and approved the budget submitted for it.

Technical Activities

Marshall Waterman outlined for Council details of the very successful Technical Committee Forum which had been held November 17-18 in Granville, Ohio. A report on this meeting is featured in another item of this News Section.

Mr. Waterman recommended that a new edition of the *IES Lighting Handbook* be considered soon, aiming at publication in January of 1958. He recommended that the revision be undertaken shortly by the Technical Committees, and that such work form a major part of their program during 1956-1957. He suggested that a Handbook Committee be appointed now to study format and other such details.

Activities of all of the Technical Committees were outlined by Mr. Crouch, Technical Director.

The annual Progress Report, Technical Committee report prepared by the Committee on Progress was presented, and approved for publication, subject to letter ballot of the Committee personnel.

Result of a letter ballot on the Technical Committee Report "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps — 1955," prepared by the Testing Procedures Committee, indicated approval of this report for publication.

Resolution

"The Illuminating Engineering Society recognizes that the fluorescent lamp, as operated on commercial ballasts, generally does not produce the light output or

January 31 Is Deadline For 1956 Conference Paper Outlines

A deadline of January 31, 1956, has been set by the Papers Committee for outlines of proposed papers for the 1956 National Technical Conference. Outlines of proposed papers, in triplicate, should be mailed to:

H. F. Davidson
Chairman, I.E.S. Papers Committee
c/o Hydro-Electric Power Commission of Ontario
620 University Avenue
Toronto 2, Ontario, Canada

consume the watts that the same lamp would if operated on the specified reference ballast.

This results in wide divergence between the published data of lumen output and wattage consumed and the results obtained in the field.

In our opinion this situation arises from two factors:

(a) Published lamp ratings are based on performance with an unrealistic reference ballast.
(b) The performance of commercial ballasts falls toward the lower limit of established tolerances.

We urge strongly that the industry groups involved study all aspects of this problem with a view to an early solution."

Favorable results of a letter ballot on the report "Proposed I.E.S. Guide for Light Performance Testing of Fluorescent Lamps" approved this report for publication.

Professor Everett M. Strong reported to Council details of a meeting of the Trustees of the Research Fund, noting especially that the Trustees suggested a change in the title of this body. Their proposed title would be "Illuminating Engineering Research Institute," their feeling being that this title would better suggest the function of the organization. They further recommended working in the Research Trust Agreement to include consultation on basic scientific data on illuminating problems. Council asked the opportunity to study these proposed changes and obtain legal counsel, approving in principle the change in the name, expansion of scope, the matter to be referred back to them for study and approval by the January Executive Committee. The Research Fund Trustees also recommended the preparation of a brochure, to be financed equally by the Fund and by I.E.S. Approved.

I.E.S. National Technical Conferences

1956 — September 17-21 — Hotel Statler, Boston, Massachusetts

1957 — September 9-13 — Biltmore Hotel, Atlanta, Georgia

1958 — August 17-22 — Royal York Hotel, Toronto, Ontario

1959 — September 7-11 — San Francisco, California

Sustaining Members

In the absence of Fred E. Guth, Chairman, Brooks Chassaing reported on the activities of this Committee. He outlined the special program being undertaken with Section and Chapter Chairmen for closely coordinated work, nationally and locally, on potential Sustaining Members. The Committee reported the application of five new Sustaining Members as follows:

The Capitol Light & Supply Company, Inc.
6-8 Huntley Place
Hartford, Conn.
Official Representative: Arnold S. Cartin

Century Lighting, Inc.
521 West 43rd Street
New York 36, N. Y.
Official Representative: Edward F. Kook

General Electric Co.
1430 E. Fairchild Street
Danville, Illinois
Official Representative: E. C. Schorr

Prescolite Manufacturing Corp.
2229 Fourth Street
Berkeley 10, Calif.
Official Representative: W. D. Runswick

The Starbuck Sprague Co.
39 Spring Street
Waterbury, Conn.
Official Representative: E. A. Madisse

Boston Conference

J. C. Forbes, Chairman of the National Technical Conference Committee reported that the schedule for the Boston Conference was now set, for a four-day meeting. He outlined details of the program for Monday through Thursday, indicating that Friday had been set aside for Committee meetings. A report from H. F. Davidson, Chairman of the Papers Committee, was read to Council indicating that they will meet in early February to appraise Conference paper outlines. Council suggested that the Papers Committee plan for as many parallel sessions as are compatible with good papers. It was anticipated that there would be three parallel sessions in the Technical program.

(Continued on page 12A)

Panhandle Chapter of I.E.S., in Amarillo, Texas, held its Charter meeting November 28. M. J. Myers, past Regional Vice-President of the Southwestern Region, made the official presentation of the Charter, as proxy for John Felton, current Vice-President, who could not attend. In the photo at left, Mr. Myers and Bob McCracken look over the Charter. In the photo at right, Tom Hart (right), Chairman of the group in its study club days, presents souvenir lighters in appreciation of the I.E.S. work done by Tom Wier (left) and Mr. Myers.

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QUIET

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Index to 1955

The index — Subject and Personnel — to Volume L, the year 1955, of ILLUMINATING ENGINEERING, will be mailed with the February 1956 issue.

(*Continued from page* 10A)

REGIONAL ACTIVITIES

A report developing from the meeting of the Regional Activities Committee, held the previous day, was presented to Council by Kirk Reid, Chairman. He noted especially that an expedient roster will be mailed to Council members in January, made up of the rosters of twenty Sections and Chapters.

Mr. Reid reported that the 1956 Regional Conferences were now all complete, and that 1957 plans would be completed soon. He noted that local committees are already studying dates and places for the 1958 Regional Conferences which may be reported at the June Council meeting.

U. S .National Committee, C.I.E. Organizes for Next 4-Year Program

Assembling for the first time since the Plenary Session of the International Commission on Illumination at Zurich, Switzerland, in June, the U. S. National Committee met October 27-28, 1955, at Skytop, Pa., to organize its work for the four-year interval before the next international meeting at Brussels, Belgium.

Dr. Ward Harrison, C. A. Atherton and Dr. A. A. Brainerd were honored as the retiring President of C.I.E., Honorary Secretary of C.I.E., and President of the U. S. National Committee respectively.

New officers were unanimously elected as follows:

H. H. Magdsick, President
W. C. Brown, Vice-President
L. E. Barbrow, Secretary
T. D. Wakefield, Treasurer

With a new change in emphasis (adopted at Zurich) *i.e.*, having working committees on certain vital subjects, appointments of United States nominations were made as follows:

1.1 — Definitions and Vocabulary — P. Presbrey
1.3.1 — Colorimetry — D. B. Judd
1.3.2 — Color Rendering — D. Nickerson
1.3.3 — Colors of Signal Lights — F. C. Breckenridge
1.4.2 — Visual Performance — G. A. Fry
2.1.2 — Sources of Ultraviolet and Infrared — L. J. Buttolph
3.1.1.1 — Predetermination — W. M. Potter and J. J. Neidhart
3.1.1.2 — Discomfort — S. K. Guth
3.1.1.3 — Pleasantness — H. L. Logan and L. S. Harrison
3.2 — Daylight — J. W. Griffith
3.3.1 — Street Lighting — C. H. Rex and D. W. Rowten
3.3.2.1 — Aviation Ground Lighting — C. A. Douglas
3.3.3 — Airborne Lighting — M. K. Laufer
3.3.5 — Automobile — V. J. Roper
3.3.7 — Signal Lights — A. H. Clarke

The Secretariats for three of the above committees have been assigned to the United States. Secretariat Directors appointed for them are:

1.3.1 — Colorimetry — D. B. Judd
1.4.2 — Visual Performance — G. A. Fry
3.3.3 — Airborne Lighting — P. H. Greenlee

At the banquet selected slides were shown by various members of their journeys abroad. A most pleasurable time was enjoyed by the men and women alike.

The Proceedings of the International Commission on Illumination Meeting in Zurich, Switzerland, covering the progress in every phase of illumination are expected shortly and will be available through Mr. J. L. Kilpatrick, Leader Division, Benjamin Electric Mfg. Co., 74 Trinity Place New York 6, N. Y.

SMPTE Plans Symposium On TV Studio Lighting

Arrangements are underway for a television studio lighting symposium covering the problems of "Transition from Black-and-White to Color TV," it was announced by Herman M. Gurin of NBC, Chairman of the Television Studio Lighting Committee of the Society of Motion Picture and Television Engineers. The symposium will take place during the 79th convention of the Society, to be held at the Hotel Statler, New York City, April 29 - May 4, 1956.

The morning session of the symposium will be devoted to the presentation of technical papers. This session will be led by Richard S. O'Brien of CBS, winner of the SMPTE Journal Award for this year. The afternoon session will feature a panel discussion to be held at an NBC studio. The panel will be composed of experts in the television studio lighting field who will discuss the current problems of lighting TV shows that are to be seen in black-and-white or in both color and black-and-white, and will answer questions from the floor.

Technical Committee Forum Stresses Role of Research in Application

Chairmen of Technical Committees met with the Officers of the Society in a two-day conference at Granville, Ohio and Columbus, Ohio November 18-19 reviewing the work done to date, the plans for the new year and discussing problems of special interest. The second day was spent at the School of Optometry of Ohio State University learning results of research on glare.

Vice-President Marshall Waterman led the meeting, pointing out the problems

(*Continued on page* 17A)

Group attending the meeting of the U. S. National Committee of the C.I.E., held at Skytop, Pa., October 27 and 28.

Why we recommend Professional Thinking on every lighting job

WE have learned from experience that most lighting installations, to be done right, should include the planning work of an architect or professional consulting electrical engineer.

That's the only way we can be sure that the top-grade kind of lighting equipment, in which we specialize, is used correctly and to its best advantage.

For this reason, we at Sylvania have continued to stress leadership in design and performance of fluorescent fixtures. We have worked to put every possible benefit into a fixture. We want you to be proud to specify and recommend it. We want it to perform for your clients for many, many years . . . to continue to reflect your good name and reputation.

For whatever lighting assistance you might wish—in school, store, office, industrial or institutional lighting problems—we invite you to call on your local Sylvania lighting specialist. He's ready to give or get quickly any data you might request on lighting problems. *Why not give him a ring?*

Key man in LIGHTING . . . who is he?
SYLVANIA
. . . fastest growing name in sight
LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

This page advertisement in Business Week, January 28, launches a series of messages to our public and your clients, outlining Sylvania policy about the role of the architect and engineer in lighting installation.

Yours for the asking . . .
Informative Sylvania booklets

Send the coupon →

SYLVANIA ELECTRIC PRODUCTS INC.
Lighting Division—Fixtures, One 48th Street, Wheeling, West Virginia

Please send me the following specification data on Sylvania fluorescent fixtures:
- ☐ Good Lighting Is Good Business (Booklet F-687).
- ☐ Some Whys and Hows of Modern School Lighting (Booklet F-615).
- ☐ Better Seeing Builds Better Sales (Booklet I-753).

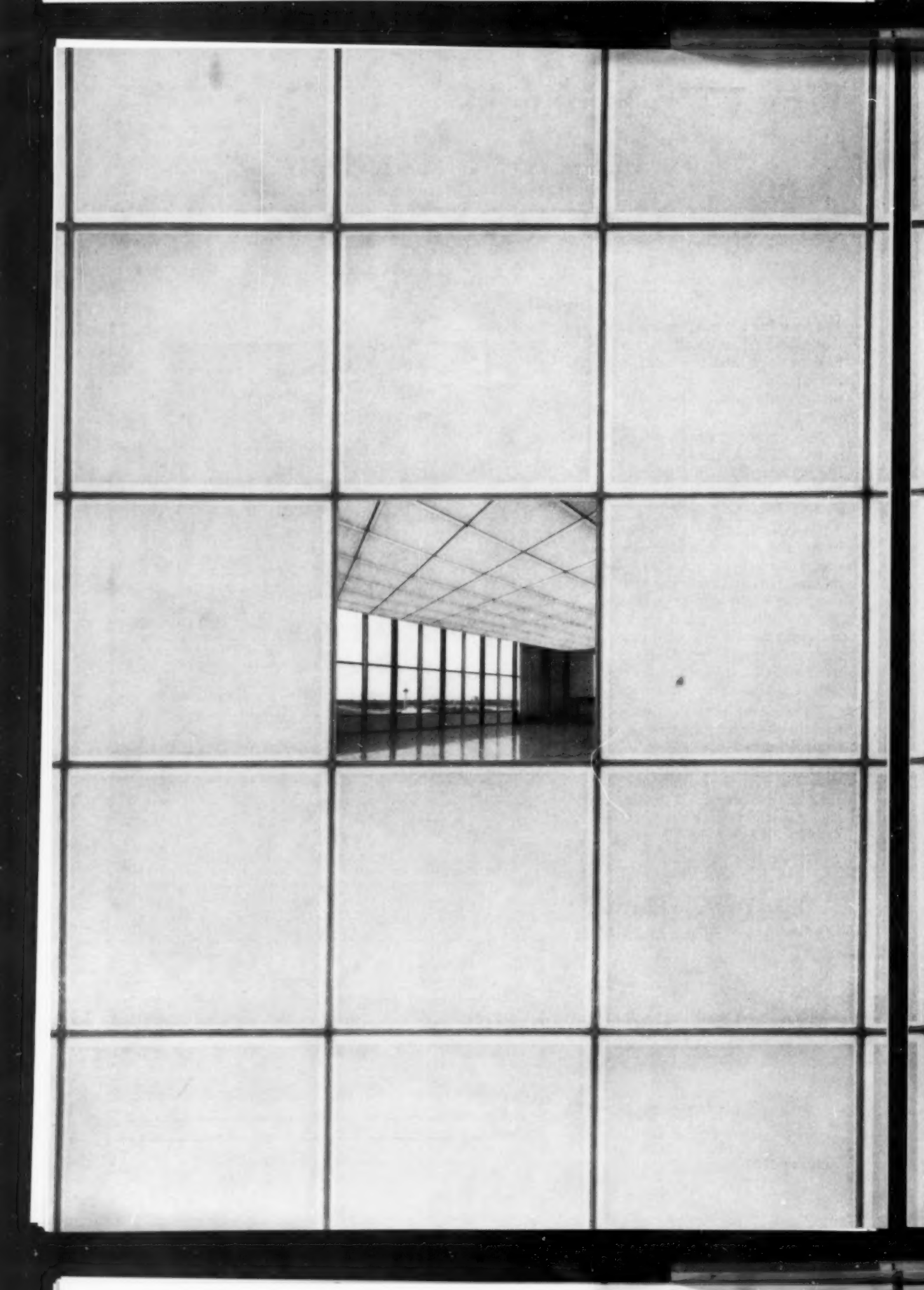
☐ Please have a Sylvania Lighting Specialist call on me.

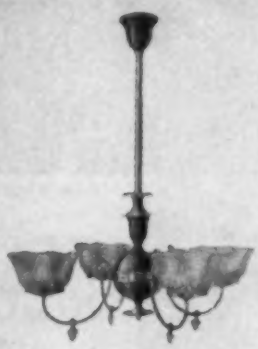
Name_____ Title_____

Organization_____

Address_____

City_____ Zone____ State_____





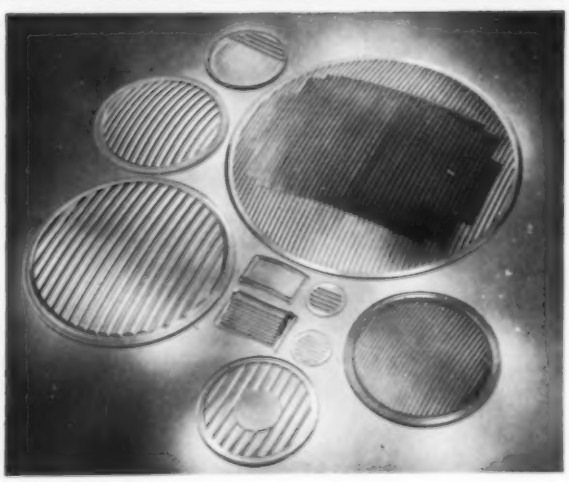
Wakefield's 1906 gas fixture contrasts sharply with the 1956 Sigma II, a 5′ x 5′ modular unit, shown at left as a 330′ x 50′ luminaire providing 240 footcandles. This striking contrast eloquently exemplifies the progress in the art of illumination made by the Illuminating Engineering Society and The Wakefield Company on their respective Fiftieth Anniversaries.

The Wakefield Company, Vermilion, Ohio
Wakefield Lighting Limited, London, Ont.

ARCHITECTS: EERO SAARINEN AND ASSOCIATES • SMITH, HINCHMAN & GRYLLS, INC.

To **Concentrate,**
Diffuse,
Deflect or
Color
a beam of light
accurately...
use

KOPP *Engineered* Lenses



Kopp Engineered Lenses are actually custom-made lenses. Because the requirements of glass products we supply vary so in function, design, color and other characteristics, it is necessary to treat each order individually from formulation of ingredients to inspection of finished product. To keep costs low and insure highest quality and uniformity, modern equipment and methods are used for melting, pressing, annealing and finishing.

You benefit from Kopp's *individualized* method of design and fabrication, for this is the only practical way to produce technical glass products with unusual combinations of properties.

We will welcome an early opportunity to develop and produce designs for your specific needs.

KOPP GLASS

KOPP GLASS, Inc.
SWISSVALE, PA.

(Continued from page 12A)

of committee work and the value of the accomplished results. President Hartenstein exhorted the committees to enthusiastic endeavor during this coming year. The work of the committees was reported in groups of allied activity with discussion periods between every four or five reports. Discussion periods provided spirited exchange on related problems. The theme of "quality" of lighting kept recurring, particularly as related to offices, schools, daylighting, street and highway lighting, motor vehicle lighting and illumination performance recommendations. The first day closed with Chairman Wakefield, Professor Strong and C. L. Crouch of the I.E.S. Research Fund pointing out the role of the Research Fund in providing answers vitally needed by the Society's Technical Committees and the recent concept of leadership in furnishing advisory service.

Dr. Glenn A. Fry and his associates at the School of Optometry presented a most interesting program on the second day describing the results of research on disability glare, the physiological basis of discomfort glare, visual performance as related to visual activity and the use of visual aids for facilitating the performance of difficult visual tasks. Drs. Jack Fugate, V. J. Ellerbrock and J. M. Enoch participated. The program ended with inspection of the various researches currently being carried on. Expressions of enthusiasm for the program were spontaneous from the visiting committee chairmen.

Lighting Training Course Conducted in Georgia

One of the major projects of the Education Committee of the Georgia Section of I.E.S. this year is the lighting training course, being sponsored in cooperation with the Georgia Power Company and the Atlanta Chapter of the National Electrical Contractors Association. The course has been especially designed for employees of NECA members, electrical engineering firms and architectural firms. Instructors for the ten sessions are all I.E.S. members.

The program is as follows:

January 10

Eye, Vision, Light Characteristics — Jack H. Murrah, Georgia Power Co.
Measurements and Nomenclature — J. Dixon Mitchell, Westinghouse Electric Corp.

January 17

Light Sources — Paul P. Harrison, Sylvania Electric Products Inc.; and Hal M. Horton, General Electric Co.

January 24

Introduction to Lighting Design — Wesley F. Johnson, Georgia Power Co.
Illumination Levels — Ray H. Hiller, Benjamin Electric Mfg. Co.

January 31

Interior Lighting Design and Review—Charles R. Minors, Georgia Power Co.; and Ed. D. Johnson, Whitman Associates

February 7

Office and Store Lighting — Cecil L. Cannon, Ruff and Cannon; and Perry G. Sessoms, Jr., Electro Silv-A-King

February 14

Problem Session and Industrial Lighting — William M. Pearson, Graybar Electric Co.; and Bert L. Trapini, Walter F. Nelson Agency.

February 21

Floodlighting Design and Problem Session — Arthur H. Lundstrom, Whitehead Electric Co.; and Harry T. Yopp, Georgia Power Co.

February 28

School Lighting and Institutional Lighting — Mrs. Reta Lee Hope, Georgia Power Co.; and Judd Lough, Holophane Co.

March 6

Residential Lighting and Architectural Lighting — Miss Betty Parker, Georgia Power Co.; and Johnnie E. Sweatte, Georgia Power Co.

March 13

Cost Analysis, Maintenance and Lighting Salesmanship — Johnny Brun, Westinghouse Electric Corp.; and J. B. Browder, Georgia Power Co.

LIGHTING CALENDAR

Society Events

April 5-7, 1956—Southern Regional Conference, Thomas Jefferson Hotel, Birmingham, Ala.

April 8-10, 1956 — Southwestern Regional Conference, Hilton Hotel, Fort Worth, Texas.

April 11-13, 1956 — South Pacific Coast Regional Conference, Mark Hopkins Hotel, San Francisco, Calif.

April 19-21, 1956 — Pacific Northwest Regional Conference, Davenport Hotel, Spokane, Wash.

April 26-28, 1956—Inter Mountain Regional Conference, Utah Hotel, Salt Lake City, Utah.

May 7-8, 1956—Great Lakes Regional Conference, Commodore Perry Hotel, Toledo, Ohio.

May 10-11, 1956—Midwestern Regional Conference, Severin Hotel, Indianapolis, Indiana.

May 17-18, 1956 — Canadian Regional Conference, Chateau Frontenac, Quebec, Canada.

May 24-25, 1956 — East Central Regional Conference, Shoreham Hotel, Washington, D. C.

September 17-21, 1956 — Illuminating Engineering Society, National Technical Conference, Hotel Statler, Boston, Mass.

Industry Events

January 23-25, 1956 — American Society of Heating and Air-Conditioning Engineers, Annual Meeting, Sheraton-Gibson Hotel, Cincinnati, Ohio.

January 23-26, 1956—Plant Maintenance & Engineering Show, Convention Hall, Philadelphia, Pa.

January 23-26, 1956—National Rural Electric Cooperative Association (14th Annual Meeting), St. Louis, Missouri.

January 30 - February 3, 1956 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York, N. Y.

February 6-9, 1956 — 5th Annual Industrial Ventilation Conference, Michigan State University, Ann Arbor, Mich.

February 23-24, 1956—12th Annual National Adequate Wiring Conference, LaSalle Hotel, Chicago, Ill.

February 26-29, 1956 — National Electric Sign Association, Annual Convention, Jefferson Hotel, St. Louis, Mo.

March 12-16, 1956 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

April 29 - May 4, 1956 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y.

May 19-20, 1956—International Home Building Exposition, New York Coliseum, New York, N. Y.

June 4-7, 1956 — Edison Electric Institute, 24th Annual Convention, Atlantic City, N. J.

Week of June 10, 1956—National Association of Electrical Distributors (48th Annual Convention), Ambassador-Chelsea Hotels, Atlantic City, N. J.

June 25-29, 1956—American Institute of Electrical Engineers, (Summer & Pacific General Meeting), San Francisco, Calif.

June 27-July 5, 1956—International Electro-Technical Committee, Munich area of Southern Germany.

October 1-5, 1956—American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago, Ill.

October 2-4, 1956—Canadian Electrical Manufactureres Association (12th Annual Meeting), Sheraton Brock Hotel, Niagara Falls, Ontario, Canada.

October 7-12, 1956 — Society of Motion Picture and Television Engineers, Ambassador Hotel, Los Angeles, Calif.

October 22-24, 1956 — American Standards Association, 38th Annual Meeting (In conjunction with Seventh National Conference on Standards), Hotel Roosevelt, New York, N. Y.

October 22-26, 1956—National Safety Council, 44th National Safety Congress & Exposition, Chicago, Ill.

November 12-16, 1956—National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

How YOU Can Sell SUSTAINING MEMBERSHIPS

It's beginning to *show!* Interest in the Sustaining Members Program, that is. In last month's edition of this department, we outlined the organizational set-up of six divisions of the S-M Committee. They lost no time in getting going, apparently; almost a record number of new Sustaining Members were elected at the Council meeting December 8, and a number of increased dues were reported as well. Best of all, the S-M groups in the Sections and Chapters are really lining up now. That's where it will count. For instance:

Chicago's unsung hero: Recently a one-page report showing S-M progress for one month nation-wide, indicated seven new and reinstated S-M members. Five of the seven, or 70 per cent, came from Metropolitan Chicago. Thereby hangs a tale. Paul Kauffman, recently retired as Lighting Director of Commonwealth Edison Company, has made I.E.S. Sustaining Membership work his life-long hobby. Paul's not a high-pressure salesman — never has been. He's a wonderful guy who goes about his job in an easy-going way, and doggedly gets it done. That's why Chicago has more S-M members, a greater percentage of the total of S-M members, and a greater variety, than any area in the country.

Lou Rosenstein has taken over the S-M Chairmanship in Chicago this year, but Paul Kauffman keeps his hand in, acting as Vice-Chairman. Lou writes that Chicago has always been proud of its S-M accomplishments, and will work harder than ever this year. That's a challenge! Can anyone overtake Chicago? And to Paul Kauffman, sincere thanks for his fine loyal, unsung contributions to I.E.S.

Rocky Mountain Section: High hopes here. Chairman Glenn Gaer of the Rocky Mountain Section has appointed Eddie Goldman of General Electric Supply Company, Denver, as local S-M Chairman. Eddie is one of those dynamic guys who gets what he goes after. He's got some mighty active distributors and some good fixture manufacturers to work on.

Council Action: Part of your S-M Sales Story must be to answer where the money goes. On October 12, the National Council of I.E.S. decided that on new or increased S-M contributions:

(1) The Sustaining Member may specify the use of his contribution between Research and other national I.E.S. functions, or

(2) If said funds are not specified as to use, two-thirds will be applied to the I.E.S. Research Fund and one-third to other national I.E.S. activities.

This Council action is of tremendous help to us salesmen. Chick Shotwell, past S-M National Chairman, asked for this specific help many times. Now, Kirk Reid of G-E came through with the above Masterpiece. Here is an *important* answer in your S-M work!

Why Research: In past years when only enough light was provided to permit people barely to see, deficiencies in basic knowledge were of relatively small consequence. However, as lighting becomes more widely understood and appreciated as a vital factor in improved visibility and well-being, such deficiencies in basic knowledge cripple the creation of the designs from which adequate applied lighting springs. That's why you, me, our industry and the public need research work by I.E.S.

Who Does the Research: There is absolutely NO influence by the I.E.S. Council, or by individual I.E.S. members as to what basic matter is worked on through I.E.S. Research. The money is turned over to an entirely separate entity, the Research Trustees, who have sole authority in its use. This autonomous group supervises basic researches in illumination, for the most part carried on in qualified Universities. I.E.S. publishes the results of these basic studies, for the benefit of all.

I.E.S. Research is at the threshold of realizing the impact of the total luminous environment upon the whole human organism. Light is life! Every I.E.S. member has a stake in S-M work to further research.

More Knowledge — and Money: It is simply a matter of more knowledge—and that requires work — and work in turn requires money. I.E.S. can only go forward if every I.E.S. member obtains contributions from Sustaining Members. Will you help? Any questions? Write: Sustaining Membership Chairman, 2615 Washington Avenue, St. Louis 3, Missouri.

British IES Announces Summer Meeting Plans

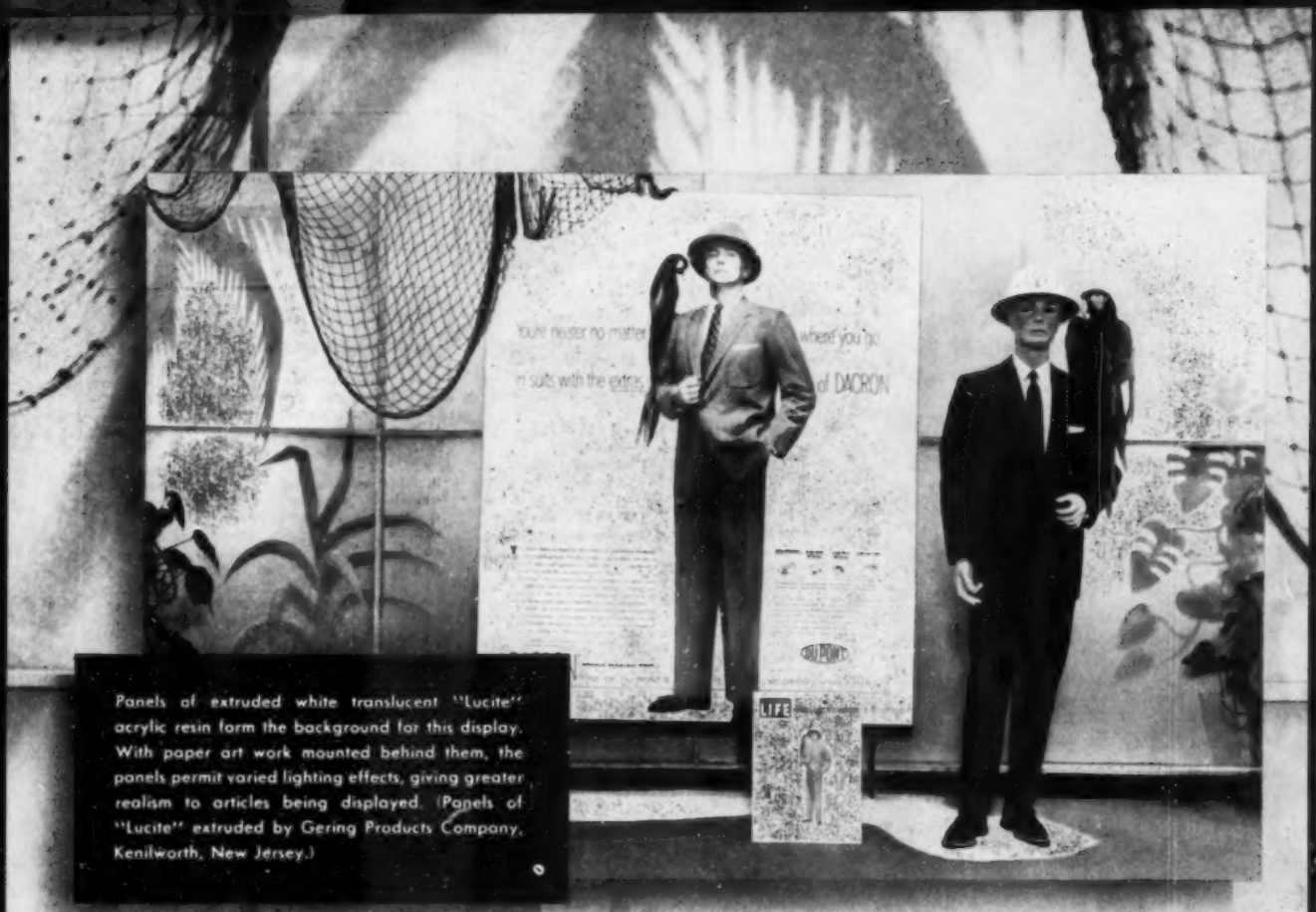
Headquarters have been set at the Majestic Hotel in Harrogate, England, for the British IES's Summer Meeting, May 8 to 11. Sessions will be held at Royal Hall.

A provisional program for the four-day conference is as follows:

Tuesday afternoon — Visits to Montague Burton, Ltd. (Leeds), J. J. L. and C. Peate (Guiseley), and Glass Bulbs Ltd., (Harworth).
Tuesday evening — Civic reception.
Wednesday morning — Light and Colour, by J. W. Strange and H. Hewitt.
Wednesday afternoon — Lighting of Small Factories, by J. S. McCulloch; and A Critical Analysis of Lighting Equipment and Its Maintenance, by C. J. Veness and J. Mortimer Hawkins.

(Continued on page 20A)

The November 3 meeting of the St. Louis Section was held jointly with the American Society of Safety Engineers, with the I.E.S. group acting as host. Guest speaker was Richard W. Scott, assistant to the Sales Manager of Crouse-Hinds Company, who spoke on "Lighting in Hazardous Places." Attendance was approximately 100. The meeting was held at the Engineers Club in St. Louis. In photo above, necks are craned to see the demonstration of equipment.



Panels of extruded white translucent "Lucite" acrylic resin form the background for this display. With paper art work mounted behind them, the panels permit varied lighting effects, giving greater realism to articles being displayed. (Panels of "Lucite" extruded by Gering Products Company, Kenilworth, New Jersey.)

Here's drama in LIGHT,

thanks to panels of Du Pont LUCITE®

Exhibits of all kinds have an accented third-dimensional effect and life-like appearance against illuminated backgrounds of extruded translucent "Lucite" acrylic resin. Color, depth and lighting are combined to give your display a drama and appeal impossible with ordinary opaque backgrounds.

"Lucite" is an ideal material for creating dramatic lighting effects. Clear "Lucite" transmits over 92% of visible light . . . carries light around curves with radii over three times the thickness of the material.

Extruded "Lucite" saves you at least 67% in weight when used in place of glass, and its engineered compositions are designed to yield optimum light transmission at maximum diffusion. "Lucite" is easy to work with and offers you unlimited opportunities for new types of display and lighting applications in buildings of all types. For information about this versatile engineering material, write to E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 531, Du Pont Building, Wilmington, Delaware.

This "Quality Controlled" label is awarded to qualified extruders of Du Pont "Lucite" acrylic resin. It is Du Pont's assurance to the lighting industry that the extruded material meets the high standard of quality established by E. I. du Pont de Nemours & Co. (Inc.)

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

(*Continued from page* 18A)

Wednesday evening — Display of new lighting equipment.
Thursday morning — Visits to Rowntrees Ltd. (York), Hailwood & Ackroyd (Morley), and J. Crawthra & Co. Ltd. (Bradford).
Thursday evening — Dinner and dance.
Friday morning — Apparent Brightness of Light Sources, by W. R. Stevens and H. M. Ferguson; Decorative Lighting, by D. W. Durrant.

Members of the American I.E.S., who might be visiting the Summer Meeting, will be having an informal get-together during the evening of Wednesday, May 9.

Western New York Section, IES, Presents 6-Week Lighting Course

"Industrial Lighting Design" was a series of six weekly meetings, with two-hour sessions, conducted by the Western New York Section of I.E.S. in Buffalo, during October and November. Those attending included people from local industrial plants and from the offices of architects, consulting engineers, electrical contractors and electrical wholesalers. Registration for the six sessions was 76, with an average attendance of 56.

The program, designed to provide grounding in the fundamentals of good current industrial lighting practice, was as follows:

October 10 — Lumen method of lighting calculations. How to use this method for calculating the equipment required to produce and maintain a given footcandle level. Point-by-point calculations.

October 17 — Lighting terms. Light measuring instruments and how to use them. Quantity and quality of illumination. How to plan the lighting for maximum comfort and seeing efficiency. Effects of glare and how to control it. Lighting layout problems.

October 24 — Light sources in common use. Characteristics of incandescent, mercury and the various fluorescent lamps. Effect of voltage, frequency, direct current, high and low temperature, restarting, power factor, dimming, radio interference, noise. Ballast characteristics. Fluorescent lamp colors. How to pick the right lamp for the job.

Listing of Sustaining Members of I.E.S. appears on pages 34A, 39A, 42A, 44A, 58A.

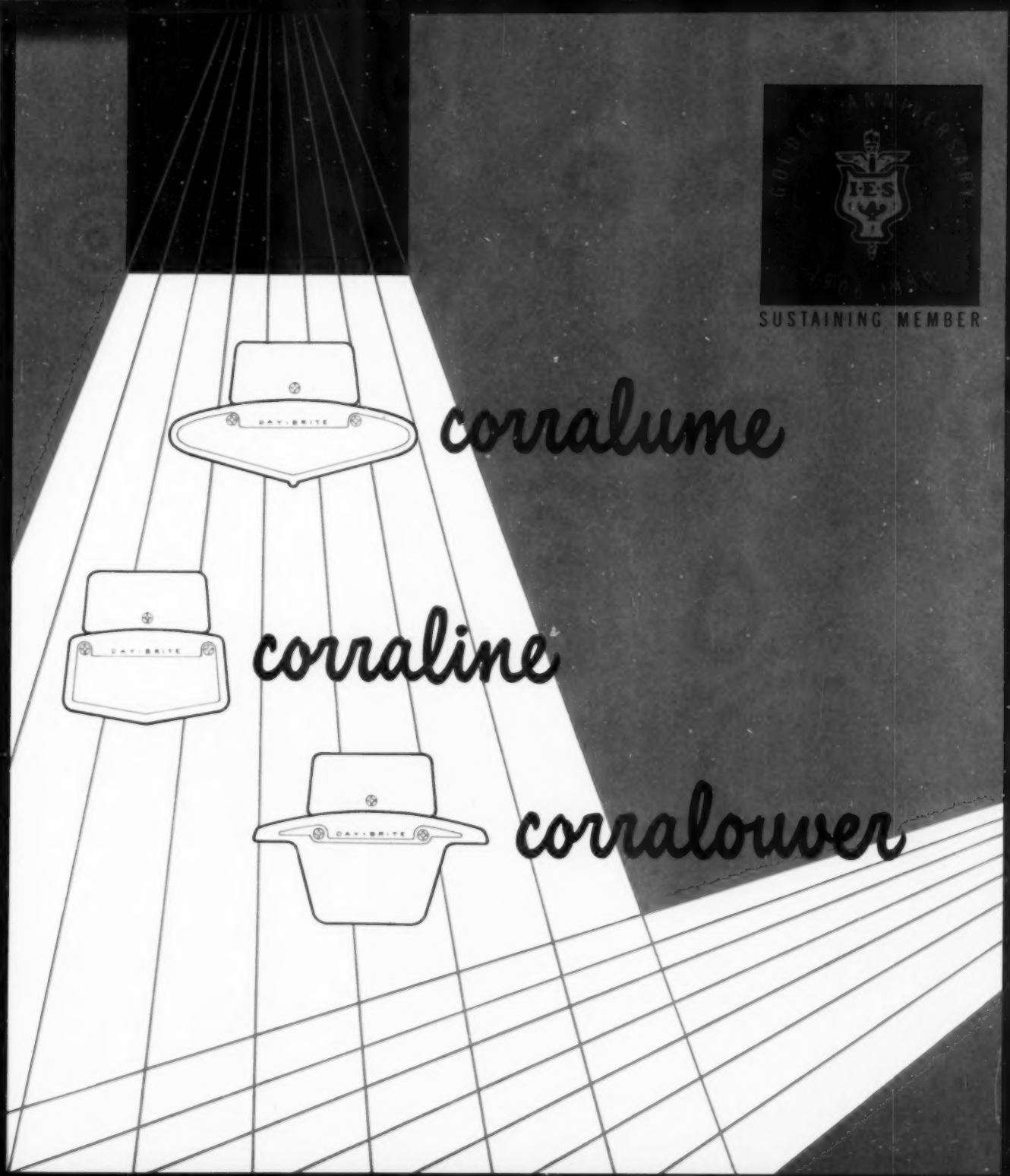
October 31 — Recognized published standards of illumination: The *IES Lighting Handbook;* The American Standard Practice for Industrial Lighting; technical reports of IES. How an understanding of these standards and their use helps in getting a better job. Lighting layout problems.

November 7 — Lighting equipment for general illumination: light distribution, types, construction, characteristics, limitations. Understanding a photometric report. Lighting cost analysis. Lighting layout problems.

November 14 — Special industrial lighting techniques. Supplementary lighting for various machines and processes. Lighting for inspection operations. Outdoor flood and protective lighting. Lighting layout problems.

(*Continued on page* 26A)

Fellow certificate is presented to C. A. B. Halvorson at the November meeting of the New England Section (left). In photo l. to r. Section Chairman W. B. Elmer, Mr. Halvorson and J. W. Young. The meeting (below) was held jointly with the Electric Institute of Boston, and Mr. Halvorson was featured speaker, with the topic of European Street and Highway Lighting.



SUSTAINING MEMBER

corralume

corraline

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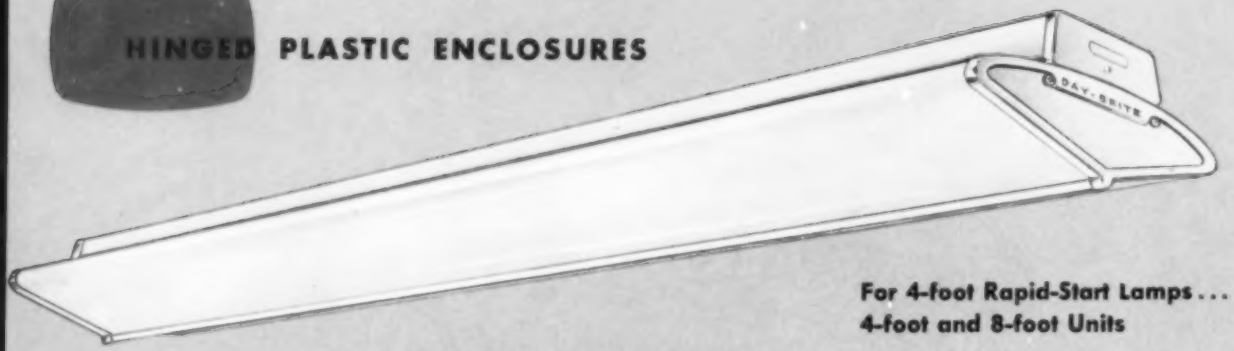
"DECIDEDLY BETTER"

DAY-BRITE

Lighting Fixtures

COPYRIGHT 1955 DAY-BRITE LIGHTING, INCORPORATED

HINGED PLASTIC ENCLOSURES



For 4-foot Rapid-Start Lamps...
4-foot and 8-foot Units

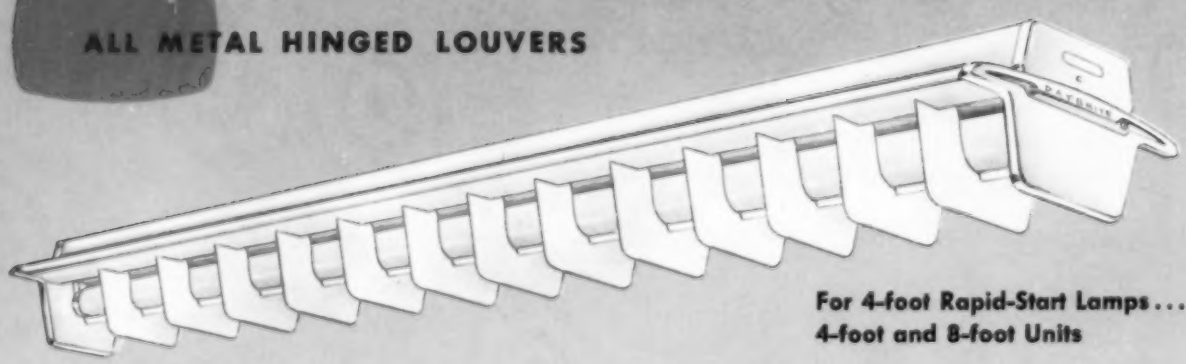
CORRALUME

HINGED PLASTIC ENCLOSURES

For 4-foot Rapid-Start Lamps...
4-foot and 8-foot Units

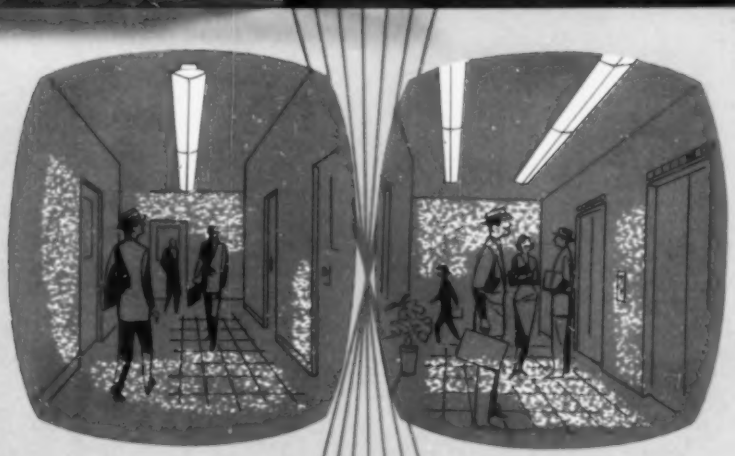
CORRALINE

ALL METAL HINGED LOUVERS



For 4-foot Rapid-Start Lamps...
4-foot and 8-foot Units

CORRALOUVER



Smart and modern in appearance, these units are designed for lighting corridors, pedestrian tunnels, and similar long narrow traffic areas. They are engineered to provide ceiling and side wall illumination, wiping out gloom and dark shadows normally found in these areas. Their extreme flexibility of application makes them ideally suited for use under balconies, in reception areas, wash rooms and powder rooms. Louvered units are ideal for bin and stack lighting.

STEEL WIRING CHANNEL rigidly formed and provided with plenty of knockouts and mounting holes for installation and feed connections. Includes outlet box cover in center of channel.

EXTRUDED PLASTIC ENCLOSURES. Two styles of one-piece extruded polystyrene plastic in 4-foot sections supported at ends and top edges by die-formed steel end plates and rails.

ALL-METAL LOUVERED ENCLOSURES. Completely interlocked assembly, all-white finish.

HINGED ENCLOSURES. Snap catches release enclosure which is supported by separable hinges in louvered position. Can be completely removed and hinged from either side.

SIMPLIFIED THROUGH WIRING. Self-bushed holes behind knockouts at each end. Units can be mounted end-to-end for continuous runs as required.

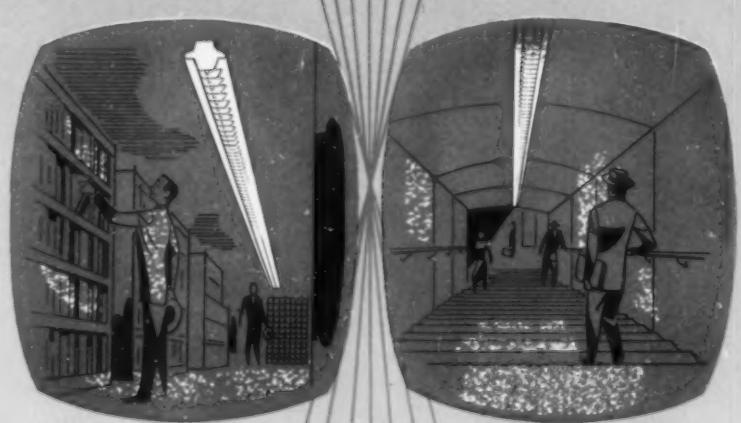
HOT-BONDED FINISH. All metal parts rust-inhibited and finished in Super-White enamel.

Designed primarily for surface mounting, all fixtures include mounting straps. Can also be suspended by the addition of standard hangers.

RAPID-START BALLASTS. HPF certified CBM, 118-volt 60-cycle, A. C. (satisfactory at temperatures to 50° F.).

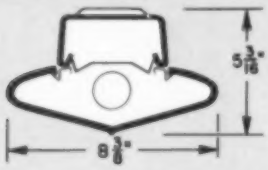
INDIVIDUALLY WIRED for single unit or continuous installations. (Thru circuit wires not included.)

APPROVED by the Underwriters' Laboratories.

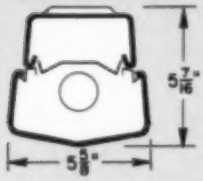


INSTALLATION DETAILS

CORRALUME



CORRALINE



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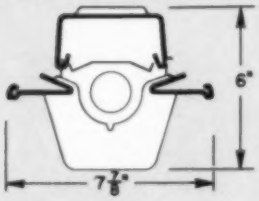
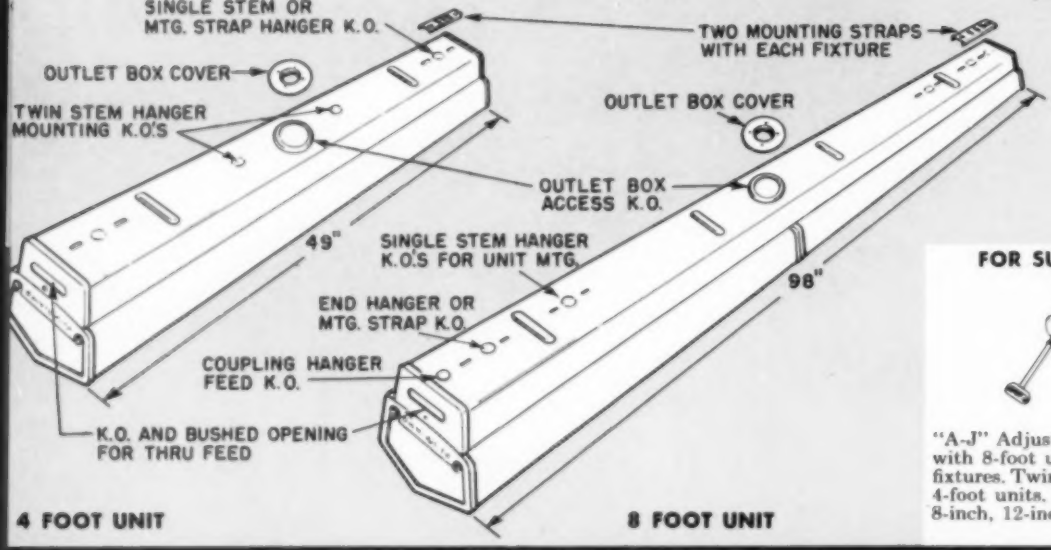



SINGLE STEM OR MTG. STRAP HANGER K.O.
TWO MOUNTING STRAPS WITH EACH FIXTURE
OUTLET BOX COVER
OUTLET BOX COVER
TWIN STEM HANGER MOUNTING K.O.'S
OUTLET BOX ACCESS K.O.
49"
SINGLE STEM HANGER K.O.'S FOR UNIT MTG.
98"
END HANGER OR MTG. STRAP K.O.
COUPLING HANGER FEED K.O.
K.O. AND BUSHED OPENING FOR THRU FEED
4 FOOT UNIT
8 FOOT UNIT

FOR SUSPENSION MOUNTING

"A-J" Adjustable Stem Hangers are used with 8-foot units and continuous runs of fixtures. Twin-Stem Hangers are used with 4-foot units. Both types are available in 8-inch, 12-inch and 24-inch lengths.

ENGINEERING DATA

CORRALUME
TYPICAL DISTRIBUTION
420 CANDLEPOWER AT 0°
2500 LUMEN LAMPS

CEILING	75%			50%		
WALLS	50%	30%	10%	50%	30%	10%
ROOM INDEX	UTILIZATION FACTORS					
J	.27	.23	.20	.26	.23	.20
I	.33	.29	.27	.31	.28	.26
H	.36	.33	.31	.34	.32	.30
G	.39	.36	.33	.37	.35	.33
F	.42	.39	.36	.40	.37	.35
E	.46	.43	.39	.43	.40	.38
D	.49	.45	.43	.46	.43	.42
C	.51	.47	.44	.47	.45	.43
B	.53	.50	.47	.50	.47	.46
A	.54	.52	.49	.51	.49	.47

CORRALINE
TYPICAL DISTRIBUTION
345 CANDLEPOWER AT 0°
2500 LUMEN LAMPS

CEILING	75%			50%		
WALLS	50%	30%	10%	50%	30%	10%
ROOM INDEX	UTILIZATION FACTORS					
J	.25	.21	.18	.24	.20	.18
I	.31	.27	.24	.29	.25	.23
H	.33	.30	.28	.32	.29	.26
G	.37	.33	.30	.34	.31	.29
F	.40	.36	.33	.37	.34	.31
E	.43	.39	.36	.40	.37	.35
D	.46	.42	.40	.43	.40	.38
C	.48	.45	.42	.45	.42	.40
B	.51	.48	.45	.47	.44	.43
A	.53	.49	.47	.49	.46	.44

CORRALOUVER
TYPICAL DISTRIBUTION
493 CANDLEPOWER AT 0°
2500 LUMEN LAMPS

CEILING	75%			50%		
WALLS	50%	30%	10%	50%	30%	10%
ROOM INDEX	UTILIZATION FACTORS					
J	.30	.25	.22	.29	.24	.21
I	.37	.32	.29	.35	.31	.28
H	.40	.36	.33	.39	.35	.32
G	.44	.40	.36	.42	.38	.36
F	.48	.43	.39	.45	.41	.38
E	.52	.48	.45	.49	.46	.43
D	.56	.52	.48	.53	.50	.47
C	.58	.55	.51	.55	.52	.50
B	.62	.58	.55	.58	.55	.53
A	.64	.60	.58	.60	.57	.55

"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

DAY-BRITE LIGHTING, INCORPORATED
ST. LOUIS 7, MO., SANTA CLARA, CALIF.

YOUR DAY-BRITE REPRESENTATIVE WILL BE HAPPY TO SHOW YOU THESE OUTSTANDING NEW FIXTURES. CALL HIM TODAY FOR A DEMONSTRATION.

How to get the lens you need

When you want a lens to make light behave the way you want it to, we'd like to help you.

You can use our staff and research facilities to solve optical problems or to confirm your own findings.

You can use our production facilities to get the shape, size and configuration lens you need.

We've been helping people obtain specialized lightingware and mass producing lenses to close tolerances, economically for over 80 years.

CORNING GLASS WORKS 33-1 Crystal Street, Corning, New York

Corning means research in Glass

Operation I.E.S.

Sustaining Members

Individual membership, in effect, *is* our Society. But our Sustaining Members too are regarded with appreciation and high esteem. Without their financial, moral and manpower support, progress over these years could not have been achieved to anything like the extent it has. In one sense, the title "sustaining" might well apply specifically; a percentage of their dues are transferred to the Society's Reserve Account. This reserve helps guarantee our continued operation in the event of a depression or economic set-back. Should hard times come, the Society would be in a position to sustain itself until normaley returned.

There is another way too, that Sustaining Members have "sustained" I.E.S. work; one not always fully recognized. I.E.S. has grown in size and stature, to no small extent because of the Sustaining Member support in providing personnel for important administrative and technical committees. These talented people have given, and still give freely, of their time and ability to I.E.S. work. Their combined efforts have kept committees ever alert to the advancement of the art of lighting. Most of the Presidents of I.E.S. came from the ranks of our Sustaining Membership companies, and these same companies have unselfishly provided many speakers for local, regional and national meetings.

Occasionally, someone expressed the thought that certain groups or even companies have some controlling influence on Society operation. How remote is this possibility would be more fully appreciated after sitting in on any committee meeting! Committee personnel is made up of members from many different companies, and from companies of widely varying interests.

What type of companies are Sustaining Members of I.E.S.? Our present roster of S-M is as follows:

Electric Utilities	117
Fixture Manufacturers	124
Lamp Manufacturers	7
Electrical Distributors and Contractors	35
Residential Equipment Mfgrs.	10
Related Mfgrs. and Misc.	47
TOTAL	340

A break-down of their dues is shown in Figure 1.

Sustaining Member dues contribute in part to a very important activity of I.E.S.—Basic Research. A proportionate part of dues is advanced to the Research Fund which, in effect, "sustains" our future. Unfortunately, we have a long way to go to support properly a suitable Research program, so essential to the science of seeing. Most of the financial support in the past has been from a few private firms, specifically earmarked for certain research projects. The burden on these few firms would be great, prohibitive in fact, were they to undertake alone a properly organized program of research on a continuing basis.

Last month we showed a chart with cost of services to I.E.S. membership totalling $22.13 per member (1953-1954). Of this amount $1.03 (average per member) is provided for Basic Research (totalling about $8,500.00). This is completely inadequate to the needs. Additional sums to this program from some Sustaining Members would not only be welcome, but the extra compensation would serve a valuable cause. Moreover, greater numbers of Sustaining Members contributing to research and other important Society activities, would bring about a better understanding of the need for more and better lighting.

How do Sustaining Members benefit from their membership? First of all, let it be said that whatever benefits have accrued in the past were from advancements of the lighting industry at large. It is only natural that non-Sustaining Members also derive benefits from an improving industry. But actual members experience even greater benefits because they are in the center of activities, and are aware of progress as it develops. Non-members are invited to sign up. When they do their support enhances the advancement of the overall operation of the lighting industry, and further benefits go to all.

Outside of research and general advancement of the lighting industry, are there any other benefits from Sustaining Membership in I.E.S. Too many to mention! The Society's technical committees total over 50 in number, with more than 500 people serving on them. These committees make available many technical reports, recommended practices, data sheets and similar material, available to members and all others interested in the technical and practical application of lighting. The results of the studies of these committees lead into the lives of working men and women; their value to both the public welfare and to the industry is incalculable.

I.E.S. now has 72 Sections and Chapters who hold annually over 500 meetings, with an attendance of something like 35,000 people. Through this vast group of local workers, a knowledge of lighting is disseminated to industrialists, office managers, school authorities, merchants, street lighting officials, and many similar types of executives. These people have learned that adequate and proper lighting does increase production, improve morale, aid in faster learning, result in more sales, and save human lives.

Advancement of the art of lighting is apparent in the fact that within recent years there has been a demand for semi-technical information, also. This desire was met by the formation of Regional zones, of which there are presently ten in the I.E.S. organization. Regional Conferences are held annually in all ten Regions, for two- or three-day periods. Talented speakers appear on these programs, giving to members and guests, the benefit of recent developments and progress in lamps, lighting and allied firsts.

Our National Technical Conferences, held annually, are gaining in popularity, recent registrations exceeding a thousand. Here are presented technical papers relating to our profession, although many practical application papers are included in the four-day sessions.

(*Continued on page* 31A)

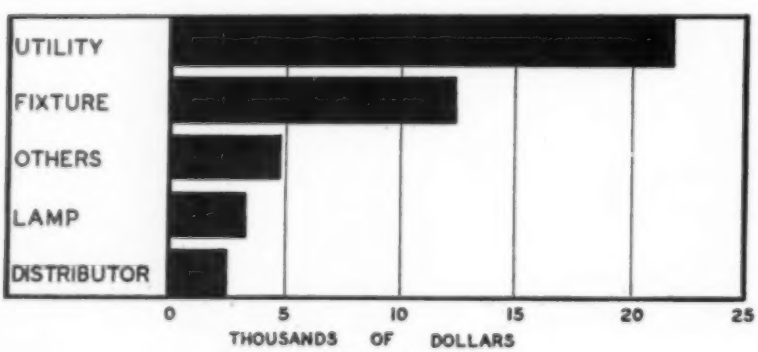


Figure 1. Sustaining Membership Dues.

This G-E development engineer is testing a ballast design for a new fluorescent application. He's a member of the largest ballast development group in the industry. The fundamental research which they perform is one important reason why G.E. is the leading supplier of fluorescent ballasts.

Flora* shows you how . . .

General Electric Ballast Design Leadership Helps You Save Lighting Dollars

General Electric's design leadership has contributed greatly to the vast fund of knowledge now available and being used by the entire ballast industry.

A recognized pioneer in ballast design, G.E. has led in these important developments: Tulamp lead-lag, certified series 96T12, trigger start, rapid start, clamped core, plastic sign, and dimming ballasts. G.E. emphasizes product leadership to provide the best ballast value to the user. We have never resorted to the temptation of lowering product quality to gain competitive advantage. Instead, we furnish only the best ballasts to assure economical fluorescent lighting. We're convinced there is no substitute for satisfactory performance.

To be sure of top quality ballasts with the latest design developments, look to the leader . . . General Electric!

The next time you specify equipment for a fluorescent lighting installation, make sure you get the best . . . specify General Electric ballasts.

A G-E ballast tag or sticker on your fixture is proof that it's equipped with the best in ballast value. It's the only way to be certain. For further information on G-E ballasts, write Section 401-15, General Electric Co., Schenectady 5, New York.

*Miss Fluorescent Ballast, G. E.'s Ballast Mascot

Copyright 1955, General Electric Company

USER SATISFACTION gets foremost consideration by G-E ballast development engineers. Here a ballast is being checked to make sure it will provide optimum light output and lamp life.

Five more reasons why

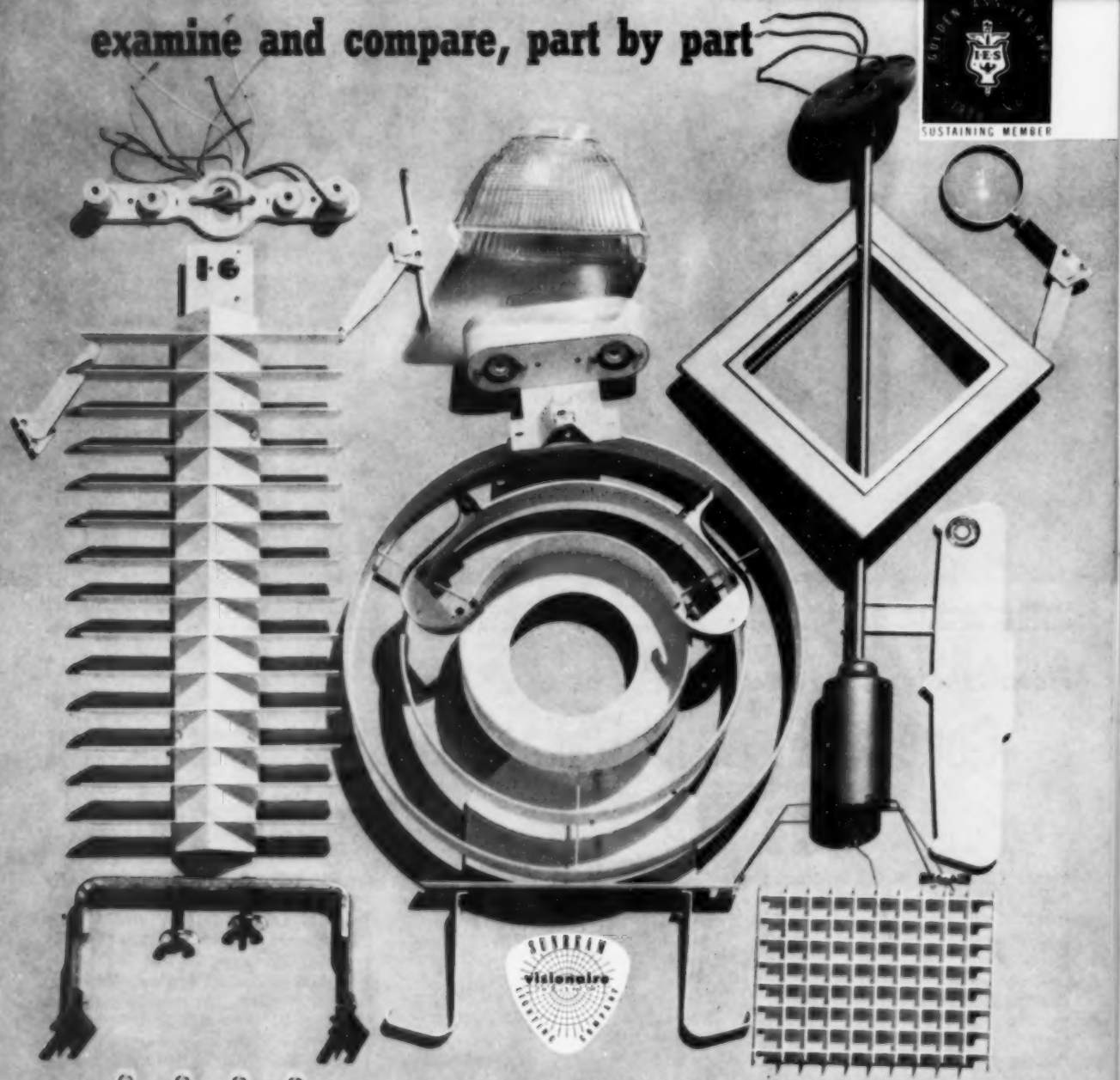
GENERAL ELECTRIC IS YOUR BEST BALLAST VALUE

- EXCLUSIVE SOUND RATING SYSTEM
- SUPERIOR QUALITY CONTROL
- LONGER BALLAST LIFE
- PRECISE LAMP-MATCHED DESIGN
- COMPLETE CUSTOMER SERVICES

Progress Is Our Most Important Product

GENERAL ELECTRIC

examine and compare, part by part



SUSTAINING MEMBER

Would you like to know how to really judge a good paint job on a lighting fixture? Write, on your letterhead, for a non-technical leaflet #EL18 on this subject.

We the engineers, designers, tool and die makers, welders, painters, assemblers; all of us at Sunbeam Lighting Company welcome with pride and confidence your critical examination of our work and products. Compare, part by part, a Sunbeam Visionaire® with another similar style and quality fixture. See for yourself our precision forming, clean welding, smooth, properly "aged" enamelling and other unexcelled examples of craftsmanship. Remember too, that only top grade steel and other materials are used in Sunbeam Visionaires®—and that all auxiliary electrical parts are E.T.L. tested and U.L. approved. Examine and compare. You will be convinced that quality Sunbeam fixtures are more economical in the long run.

SUNBEAM

LIGHTING COMPANY, 777 EAST 14TH PLACE, LOS ANGELES 21

RAIN OF INCANDESCENTS (FROM CALIFORNIA)

Rain in California is somewhat of a myth — not so with Sunbeam engineered lighting. A leader in the development of quality fluorescent lighting, Sunbeam also offers a very extensive line of incandescent luminaires. Over 96 recessed variations with Holophane Controlenses* are available to fulfill any specific lighting need — from widespread control for low ceiling areas to concentrating distribution for dramatic accents; from tamper-proofed Hi-Stress lenses for psychiatric locations to tinted lenses for complimenting complexions. Installation is greatly simplified by a choice of shallow or deep, wide or narrow enclosures; unwired or prewired; top service or bottom access. The silvertoned, die-formed, seamless trim passes every critical examination for quality. Make Sunbeam Lighting your one source of all lighting.

* Ⓡ Holophane Co., Inc.

SUNBEAM
LIGHTING COMPANY
777 EAST 14TH PLACE • LOS ANGELES 21

slimline LEAD-LAG ballasts . . .
for lighting economy

Above fixture equipped with series ballast. Lamp on right has burned out, causing left lamp to burn at reduced light output. With *lead-lag* ballast, left lamp would burn at full output.

You can stop him from throwing out good lamps!

Stop this maintenance man from discarding what he thinks is a burned-out lamp—specify Westinghouse slimline *lead-lag* ballasts for independent lamp operation. With *lead-lag,* when one lamp burns out, the other lamp is not affected; with a series-type ballast, when a lamp burns out, the other lamp operates at reduced output or goes out completely.

Westinghouse slimline *lead-lag* ballasts at a new low price, operate cooler, quieter, more efficiently. Fewer lamination joints minimize vibration; new UI core design and clamping method reduce iron losses; electrical losses are reduced, and heat is distributed more evenly. More information on this new ballast design?

See your Westinghouse representative for complete details, or write Westinghouse Electric Corporation, Lighting Division, Edgewater Park, Cleveland, Ohio.

J-04388

YOU CAN BE SURE...IF IT'S

Westinghouse

(Continued from page 26A)

There are but a few of the advantages to be gained from Sustaining Membership support. Perhaps it could be quickly added up by saying that 30 years ago we were talking about lighting as representing two per cent of the total cost of a building. Today it is more of the order of 10 per cent, and has exceeded 20 per cent where really outstanding lighting has been installed in modern buildings. These may be business benefits, to be sure, but it is the working men and women who benefit the most; good lighting makes for more comfortable seeing. We are convinced that this means easier seeing while at work, with less tension and strain, and more pleasant living during off hours.

We are fortunate to have as National Sustaining Membership Chairman, Fred E. Guth. We say fortunate, because Fred has been in the field of lighting for many years and he knows what's good for the business. He knows too that it takes captains and lieutenants and "p.f.c.'s" to get a job done. Because of this, he has found a staff of committee workers the like of which has never before been seen. Fred says that contributions can easily be increased by 50 per cent of what they are today. All it takes is telling the story of "benefits" to present Sustaining Members who are not fully aware of what their contributions mean to the Society, to them, and to the lighting profession. And the same story told to nonmembers may quicken their appreciation of the value of Sustaining Membership in I.E.S.

Every single member on Fred Guth's committee, we feel sure, will seriously work for the principles outlined in the campaign. Because they are sound, there will be many company officials wanting to learn the facts on why Sustaining Members are important to the Society, and to the lighting industry. — G. J. TAYLOR, *General Secretary, I.E.S.*

Regional Activities meeting held by East Central Region's Section and Chapter officers, November 17 at Harrisburg. Left to right, seated: Harold Oerting, Capital Section; William Mackinney, Philadelphia Section; Hugh S. James, Pittsburgh Section; A. D. Hinckley, I.E.S. Executive Secretary; N. C. Warner, Regional Vice-President; C. E. Sparrow, Maryland Section; H. D. Wolfe, Maryland Section; Samuel Charlesworth, Capital Section; Standing: D. C. Thomas, Pittsburgh Section; Ford M. Gochenaur, Eastern Pennsylvania Section; Benjamin Goodman, Capital Section; Charles Oerkvitz, Eastern Pennsylvania Section; E. W. Kelsey, Eastern Pennsylvania Section; Wm. Wagner, Philadelphia Section; J. A. Hodges, Pittsburgh Section.

Store Modernization Information Centers Announced

The Store Modernization Institute announces that it will place information centers and exhibits in several of the important retail trade association conventions held annually. The information center in each convention will include a miniature store, planned by a leading store designer, and a collection of colored transparencies of recently modernized stores in that particular retail trade. The centers will distribute the latest how-to literature and information on store modernization. The latest books will be available. New materials and equipment needed to modernize and operate stores will be exhibited, such as store fronts, lighting, flooring, air conditioning, wall coverings, store fixtures and show cases, merchandise handling and office equipment.

Residence Lighting Forum Scheduled in St. Louis

Plans for the 1956 program for the St. Louis Section's Residence Lighting Forum have been made by the group's Home Lighting Committee, Nelson Bleisch, Chairman. The schedule and speakers for the five scheduled meetings are:

January 24, Ted Cox, Managing Director of the American Home Lighting Institute, will speak on "Lighting America's Roomy Homes." Lee Wallace, Westinghouse Lamp Division, will be the speaker for the second meeting on February 28.

The third meeting to be held March 27, will feature Doctor O. C. Jandor, immediate past president of the Missouri State Optometric Society. And on April 24, the Forum speaker will be R. W. Minett, Jr., Vice-President of Moe Light Inc., Thomas Industries. The last meeting will be held May 29, with Jan Reynolds, Home Lighting Consultant, Sylvania Electric Products, Inc., as the guest speaker.

OBITUARIES

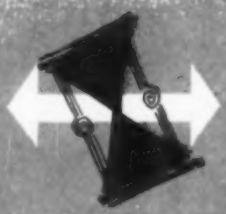
Harry Grattan, illuminating engineer with the Potomac Electric Company in Washington, D. C., died December 17 after a long illness. He was 53 years of age.

Mr. Grattan had long been an active member in the I.E.S., both nationally and in the Capital Section. He first joined the Society in 1928, and served it on many of its General and Technical Committees. He was Regional Vice-President of the East Central Region in 1947-1949.

Beginning his career in the lighting field with the Holophane Company in 1923, Mr. Grattan was briefly with Chester W. Snyder and Associates, and came to Potomac Electric Company in 1941.

Robert E. Steele, Manager, Lighting Sales Department, Northern States Power Company, died November 27, at the age of 61, from a heart attack. During his thirty-one years with the utility company, Mr. Steele was an active and well-known figure in civic, industry and I.E.S. affairs. He was a Charter Member of the Twin City Section and Chairman of the Section during 1946-1947. He was a member of the Society since 1937.

(Continued on page 76A)



"WE'RE PROUD TO BE MEMBERS OF THE I. E. S...

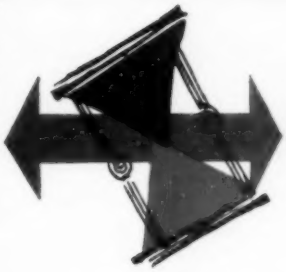
. . . and especially as we evaluate the accomplishments of the Society over its first half-century of progress. From the setting of lighting standards to the establishment of research projects, the Illuminating Engineering Society has been of tremendous assistance to our industry, and we at Smithcraft Lighting Division fully recognize and appreciate these contributions.

"We're happy, too, that the Golden Anniversary of the I.E.S. will be celebrated in our neighboring city of Boston. We look forward to meeting and greeting our many friends and associates in the Society at the Convention.

"From all of us at Smithcraft, heartiest congratulations to the I.E.S. on its fiftieth birthday!"

J. J. Smith
President
SMITHCRAFT LIGHTING DIVISION

SUSTAINING MEMBER



LET'S LOOK BACK INTO THE FUTURE!

Looking backward sometimes gives a clear indication of what the future holds. Take the lighting industry. When one company stands out because of its impressive record of leadership, you can be certain that this company will set trends in the years ahead.

We at Smithcraft are proud of the past, because it **does** reveal the imposing number of developments which we introduced to the industry. Some are listed on this page . . . all are reflected in the reputation we believe we've gained as the leader in the design and manufacture of "America's Finest Fluorescent Fixtures".

We're continually "looking forward"! We've more than doubled our facilities and production area to over six acres of floor space in active use. Our design and production departments constantly anticipate the lighting needs of the future. This policy of continuous progress assures that Smithcraft will always be identified as "America's Finest Fluorescent Fixtures".

DEVELOPMENT of shallowness in fixture design by dropping fixture housing between lamps.

DEVELOPMENT of wide-louvered fixture, creating large "area-of-light" source — over 24 square feet.

DEVELOPMENT of one-piece canopy and stem set eliminating necessity of fixture strap.

DEVELOPMENT of quick-release louvers, incorporating built-in release from either side.

DEVELOPMENT of intersection-welded louvers, an exclusive welding process, resulting in unequalled rigidity and stability.

DEVELOPMENT of transverse uplighting*, providing even, glare-free illumination without "hot-spots".

DEVELOPMENT of simplicity of troffer installation devices, including exclusive Aligner Hanger*, introducing unequalled flexibility of adjustment.

DEVELOPMENT of overall lighting system as a completely integrated lighting fixture.

DEVELOPMENT of new industrial design featuring new fixture width (over 16"), uplighting of over 20% and a high coefficient of utilization.

*REG. U.S. Pat. Nos. 2,459,034 2,559,640 (Re-issue) 23,485 2,597,875

The current Smithcraft catalog is a compilation of the newest and most functional lighting fixtures produced today. Write for your copy.

Smithcraft
LIGHTING DIVISION
CHELSEA 50, MASSACHUSETTS

SUSTAINING MEMBERS

PUBLIC UTILITIES

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

Arizona Public Service Co.
P. O. Box 2591, Phoenix, Ariz. *Don Willis*

Arkansas Power & Light Co.
Little Rock, Ark. *Max Sudduth*

Atlantic City Electric Co.
1600 Pacific Ave., Atlantic City, N. J. *John B. Taylor*

Baltimore Gas & Electric Co.
1212 Lexington Bldg.
Baltimore 1, Md. *M. C. Albrittain*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570
Lansing 3, Mich. *R. S. Ernsberger*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St.
Vancouver, B. C., Canada *H. N. Walters*

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *Robert W. Dowd*

Cambridge Electric Light Co.
Cambridge 29, Mass. *James L. Corrigan*

Central Hudson Gas and Electric Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
516 Jefferson Ave. S., Peoria 2, Ill. *W. F. Bolle*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Louisiana Electric Co., Inc.
P.O. Box 1096, Lafayette, La. *J. R. Gaugler*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central Power & Light Co.
P.O. Box 2121
Corpus Christi, Texas *James M. Williams*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio *J. R. Hartman*

City of Burbank, California Public Service Dept.
164 W. Magnolia Boulevard, Burbank, Calif. *Ralph Foy*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *L. W. Grayson*

City of Riverside Light Dept.
P.O. Box 826, Riverside, Calif. *A. J. Kennedy*

City of Seattle, Dept. of Lighting
1015 Third Ave., Seattle 4, Wash. *P. C. Spowart*

City of Tacoma
Dept. of Pub. Util., Light Div.
PO Box 1639, Tacoma 1, Wash. *Roy H. Weston*

The Cleveland Electric Illuminating Co.
75 Public Square, Cleveland 1, Ohio *R. C. Hienton*

Columbus and Southern Ohio Electric Co.
215 North Front Street
Columbus 15, Ohio *H. S. Corn*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *G. K. Hardacre*

Connecticut Light & Power Co.
P.O. Box 2010, Hartford 1, Conn. *A. M. Wade*

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *J. F. Gunther*

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power District
1452 25th Ave., Columbus, Nebr. *W. H. Sinke*

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *C. A. Tatum*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del. *W. A. F. Pyle*

Dept. of Water & Power, City of Los Angeles
Box 3669, Terminal Annex, 207 So. Broadway
Los Angeles 54, Calif. *Ivan L. Bateman*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Taylor*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Florida Power & Light Co.
Box 3100, Miami 30, Fla. *R. J. Bradley*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga. *C. M. Wallace, Jr.*

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *R. A. Landry*

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn. *Victor Ouellette*

Hydro-Electric Power Comm. of Ontario
620 University Ave., Toronto, Ont. *R. L. Hearn*

Illinois Power Co.
154 East Main St. (Box 511B)
Decatur 70, Ill. *Allen Van Wyck*

Interstate Power Co.
1000 Main St., Dubuque, Ia. *R. C. Halcombe*

Iowa Electric Light & Power Co.
Box 351, Cedar Rapids, Ia. *Sutherland Dows*

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa *John M. Hollingsworth*

Iowa Power and Light Co.
312 Sixth Ave., Des Moines 9, Iowa *N. Bernard Gussett*

Iowa Public Service Co., East Div.
400 Commercial St., Waterloo, Iowa *C. R. Wagoner*

Iowa Public Service Co., Sioux City Division
P.O. Box 778, Sioux City 4, Iowa *C. R. Tracy*

Jersey Central Power & Light Co.
501 Grand Ave.
Asbury Park, N. J. *E. R. Drechsel, Jr.*

Kansas City Power & Light Co.
P. O. Box 679
Kansas City 10, Mo. *Glenn S. Young*

Kansas Gas & Electric Co.
P.O. Box 208, Wichita, Kans. *H. W. Hobson*

Louisiana Power & Light Co.
142 Delaronde St., Station "A."
New Orleans, La. *C. L. Osterberger*

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *Harold E. Ayer*

Metropolitan Edison Co.
412 Washington St., Reading, Pa. *T. O. McQuiston*

Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson, Miss. *B. M. Davis*

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn. *W. L. Hayes*

The Montana Power Co.
40 East Broadway, Butte, Mont. *D. J. McGonigle*

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall
Pasadena 1, Calif. *T. M. Goodrich*

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I. *C. R. Broadhead*

New Bedford Gas & Edison Light Co.
693 Purchase St., New Bedford, Mass. *W. S. Fenstermacher*

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La. *E. N. Avegno*

New York State Electric & Gas Corp.
62 Henry St., Binghamton, N. Y. *Earle C. Edwards*

Niagara Mohawk Power Corp.
300 Erie Blvd. W., Syracuse 2, N. Y. *R. H. Stratton*

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind. *J. C. Sackman*

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Nova Scotia Power Commission
Halifax, N. S. *A. T. Dean*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *Franklyn Dickinson*

The Ohio Power Co.
301-315 Cleveland Ave., S. W.
Canton 2, Ohio *R. W. Osterholm*

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla. *E. W. Gray*

Omaha Public Power District
720 Electric Bldg., Omaha 2, Neb. *E. E. Schwalm*

Pacific Gas & Electric Co.
245 Market St., San Francisco 6, Calif. *O. R. Doerr*

Pacific Power & Light Co.
920 S. W. Sixth Ave.
Portland 4, Ore. *F. M. Reis*

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa. *Howard E. Ross*

Pennsylvania Power Co.
19 E. Washington St.
New Castle, Pa. *P. G. Dingledy*

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa. *J. M. Stedman*

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa. *R. G. Rincliffe*

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *T. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md. *C. D. Lyon*

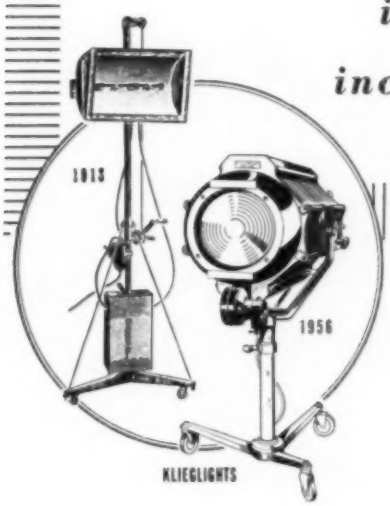
Public Service Co. of Colorado
900 Fifteenth St., Denver, Colo. *H. T. Rankin*

Public Service Co. of Indiana, Inc.
1000 E. Main, Plainfield, Ind. *Robert McMurray*

(Continued on page 39A)

ANNIVERSARIES ARE FUN...

if the years have been increasingly productive...



More than 50 years ago KLIEGL BROS. first gained recognition as authorities on lighting equipment ...as originators of effects that were dramatically different...as creators of newer and better ways to use electric light.

Today, and all through the years, recognized authorities...architects, engineers, designers, decorators and others...those people who create our modern homes, offices, schools, theatres, churches, hotels and community centers, look to Kliegl Bros. for illumination that is functional and distinctive.

For Kliegl, the years have been productive, exemplified by just a few of the fine installations where our fixtures are used such as the Church of Our Lady Queen of Martyrs, Bowdoin College, Jones Beach Marine Stadium, Radio City Music Hall, Desert Inn at Las Vegas, Madison Square Garden, residence of Hugo V. Neuhaus, Houston, Texas and New York offices of Cluett, Peabody & Company.

Today, our finest and most complete line of Lighting Fixtures is catalogued. Send for a copy, No. A-11-D, as a comprehensive aid in solving your lighting problems. Consultation, estimates and collaboration available on any lighting project, regardless of size.

Over 60 years of continuous service

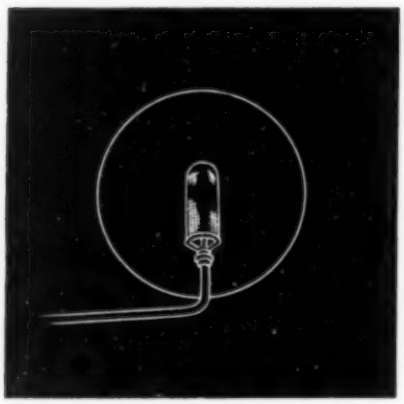
KLIEGL BROS
Lighting
321 West 50th Street New York 19, N.Y.

Originators and Manufacturers of Klieglights

REGRESSED LENS.
FIXED BEAM DOWN-LIGHTS. ELLIPSOIDAL TYPE.
PINHOLE DOWNLIGHTS. STRAIGHT MODELS.
ADJUSTABLE BEAM DOWNLIGHTS. ANGULAR MODEL.

IMPERISHABLE

Yesterday . . .



and . . .

1906
1956

CONGRATULATIONS

to the

ILLUMINATING ENGINEERING SOCIETY

on the Occasion of Its

50th ANNIVERSARY

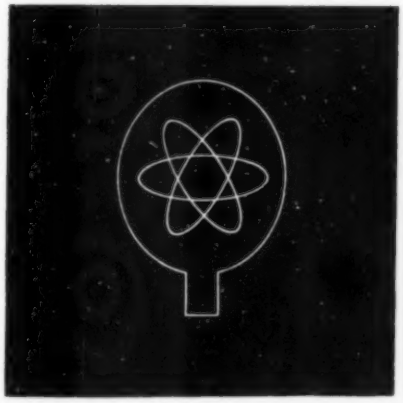
from the

HOLOPHANE COMPANY, Inc.

We Salute the Society's Achievements for the Advancement of Lighting

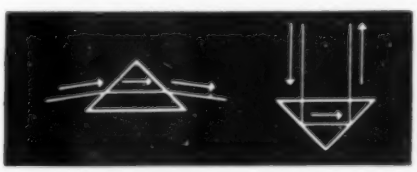
Old records provide evidence of the fact that Holophane and the Illuminating Engineering Society have maintained a close relationship since the founding of the Society . . . At the end of 1905, Mr. Van Rensselaer Lansingh, Sales Manager of Holophane, and Mr. L. B. Marks, Consulting Engineer, conceived the idea of forming a national society of lighting engineers "to coordinate practices . . . promote economics . . . advance the science and art of the lighting business" . . . Subsequently, at a dinner-meeting of twenty-five men, Mr. Otis Mygatt (founder of Holophane) proposed the name "Illuminating Engineering Society", which was adopted . . . On January 10, 1906, at the inaugural meeting of the Society, Mr. Marks was elected President; Mr. Lansingh was voted first Treasurer; Mr. E. L. Elliott, Holophane, became a member of the first Board of Managers.

PRINCIPLES...

Today . . .  and Tomorrow

Since 1898...HOLOPHANE Has Pioneered in Lighting Progress

Through the years, Holophane lighting contributions have stimulated the industry to work for ever-higher standards . . . In every major phase of lighting—incandescent, fluorescent and mercury-vapor—Holophane has set the pace . . . Now, at headquarters and in its engineering centers, Holophane carries forward its "imperishable principles" . . . creating many new application techniques and product developments in anticipation of the better lighting of tomorrow.



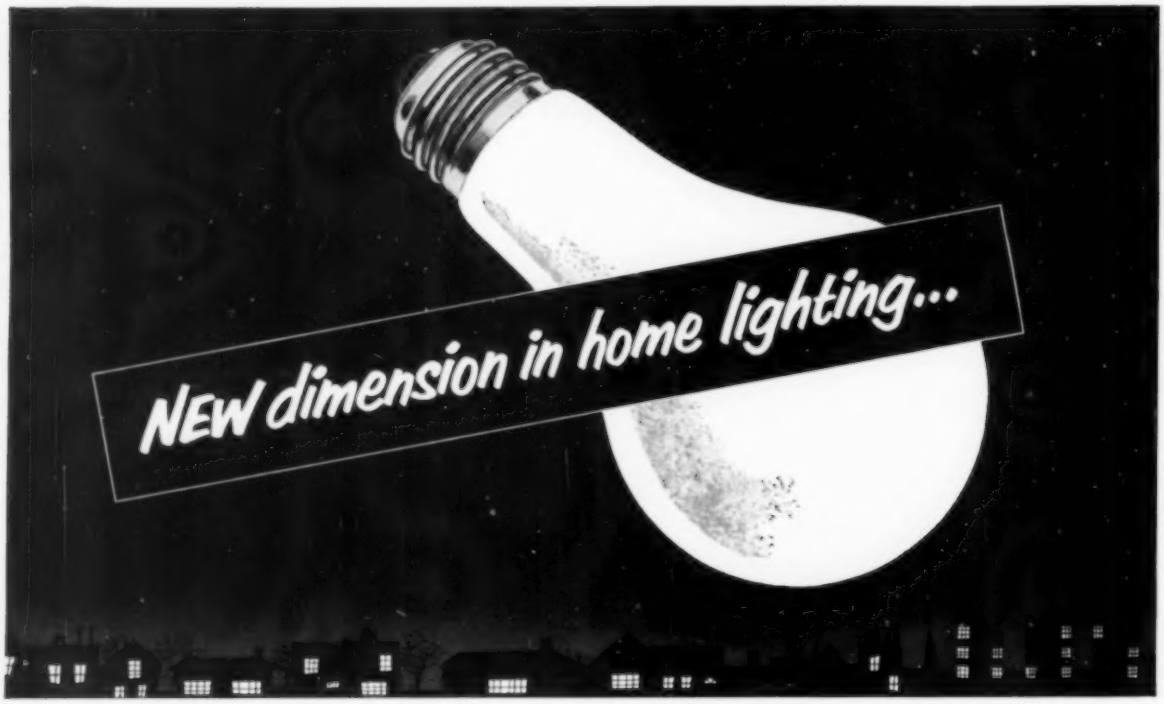
Holophane
Trade Mark

1898
1956

HOLOPHANE COMPANY, Inc.

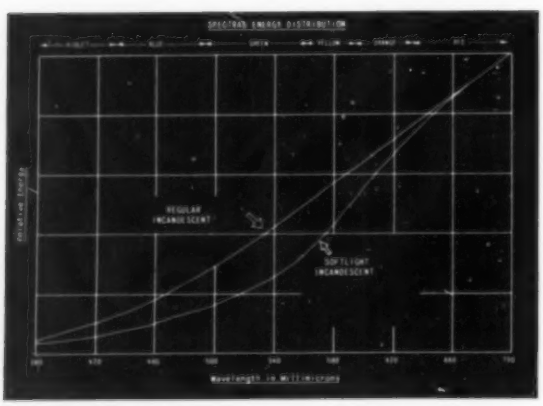
342 Madison Ave., New York 17, N. Y.

THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO



Sylvania Softlight

pearl-pink bulb decorates as it illuminates



New Sylvania Softlight spectrum has greater quantities of warmer colors than regular incandescent lamps. More perfect diffusion, for sake of aesthetic appeal, cuts down over-all lumen output slightly.

Homeowners nationwide are buying up new Sylvania Softlight bulbs. Here is the long sought new dimension in home lighting . . . the newest concept in interior design. Now, beyond the basic dimensions of *quality* and *quantity* of light, Softlight captures the third dimension of *aesthetic appeal*—brings exciting new warmth, cheer, color accentuation into the home.

Softlight bulbs carry a special pearl-pink coating which filters out cooler colors of the spectrum—blue, green, yellow—and plays up the warmer hues. Greater masking of the filament softens, shadows, reduces glares. *Result:* a warm, pleasing, off-white glow that harmonizes with and favors warm-colored furnishings . . . flatters human complexions as well.

Yes, *decorating with light* is exciting news for you too! Be sure *you* have all the facts.

SYLVANIA®

LIGHTING • RADIO • ELECTRONICS
TELEVISION • ATOMIC ENERGY

GOLDEN ANNIVERSARY
I·E·S
1906 1956
SUSTAINING MEMBER

Sustaining Members — Public Utilities

(Continued from page 34A)

Public Service Company of New Mexico
P. O. Box 1360
Albuquerque, N. M. *Stanley Bazant, Jr.*

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J. *H. P. J. Steinmetz*

Puget Sound Power & Light Co.
860 Stuart Bldg.,
Seattle 11, Wash. *Frank McLaughlin*

Quebec Hydro-Electric Commission
107 Craig St., West
Montreal, Que. *Paul E. Poitras*

Quebec Power Company
P. O. Box 1607, Quebec, Que. *Jean Saint-Jaques*

Rochester Gas & Electric Corp.
89 East Ave., Rochester 4, N. Y. *L. C. Twichell*

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

St. Joseph Light & Power Co.
520 Francis St., St. Joseph 2, Mo. *F. P. O'Connor*

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif. *H. G. Dillin*

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que.
Chas. H. Talbot

Southern Calif. Edison Co.
601 West 5th St., Los Angeles 53, Calif.
Roy E. Dahlin

Southern Canada Power Co., Ltd.
355 St. James St., West, Montreal, Que.
George R. Atchison

Southern Colorado Power Co.
Box 75, Pueblo, Colo. *E. H. Pemberton*

Southern Indiana Gas & Electric Co.
P.O. Box 569, Evansville 3, Ind. *C. K. Graham*

Southwestern Gas & Electric Co.
Box 1106, Shreveport, La. *E. F. Graham*

Southwestern Public Service Co.
P. O. Box 1261
Amarillo, Texas *A. R. Watson*

Suburban Electric Co.
157 Pleasant St.,
Malden, Mass. *Warren K. Lewellen*

Tampa Electric Co.
Cass & Tampa Sts., Tampa 1, Fla. *W. C MacInnes*

Texas Electric Service Co.
Electric Bldg.
Fort Worth 1, Texas *O. G. Carlson*

Texas Power & Light Co.
P. O. Box 6331
Dallas 22, Texas *Ted B. Ferguson*

Toledo Edison Co.
Edison Bldg.,Toledo 4, Ohio *John K. Davis*

Toronto Hydro-Electric System
14 Carlton St., Toronto 2, Ont. *Wilson J. Wylie*

Union Electric Co. of Missouri
1825 Gratiot St.
St. Louis 1, Mo. *Merrill E. Skinner*

The United Illuminating Co.
80 Temple St., New Haven 6, Conn. *E. B. Haskell*

Utah Power & Light Co.
Box 899, Salt Lake City 10, Utah *W. A. Huckins*

Virginia Electric & Power Co.
Richmond, Va. *J. G. Holtzclaw*

The Washington Water Power Co.
P.O. Drawer 1445, Spokane 6, Wash.
Gordon F. DeFoe

West Penn Power Co.
Cabin Hill, Greensburg, Pa. *R. G. MacDonald*

The Windsor Utilities Comm., Hydro Div.
149 Chatham St., W., Windsor, Ont. *W. A. Shaw*

Wisconsin Electric Power Co.
Public Service Bldg.
Milwaukee 1, Wis. *G. W. Van Derzee*

Wisconsin Power & Light Co.
122 W. Washington Ave.
Madison 1, Wis. *M. R. Norton*

Wisconsin Public Service Corp.
Green Bay, Wis. *A. G. Bur*

Worcester County Electric Co.
939 Southbridge St.
Worcester 3, Mass. *Donald S. Bennett*

LIGHTING EQUIPMENT MANUFACTURERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Advance Transformer Company
2950 No. Western Avenue
Chicago 18, Ill. *A. E. Feinberg*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada
W. A. Dalrymple

Appleton Electric Co.
1701-1759 Wellington Ave.
Chicago 13, Ill. *Norton Appleton*

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio
George E. Glatthar

B M D and S Inc.
7020 Walker St., St. Louis Park
Minneapolis 16, Minn. *Cecil H. Branham*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *Benjamin S. Benson*

Canadian General Electric Co., Ltd.
Industrial Products Division
212 King St., Toronto, Ont. *R. M. Love*

Canadian Line Materials, Ltd.
Postal Station H., Toronto 13, Ont., Canada
L. E. Messinger

Century Lighting, Inc.
521 W. 43rd St.
New York 36, N. Y. *Edward F. Kook*

Celine, Inc.
P. O. Box 348, Batavia, Ill. *Rudolph C. Hultgren*

C. W. Cole & Co., Inc.
320 E. 12th St., Los Angeles 15, Calif.
Russell W. Cole

Columbia Electric & Mfg. Co.
Box 2180, Spokane, Wash. *Walter A. Toly*

Commercial Light Co.
841 W. Washington Blvd.
Chicago, Ill. *Michael R. Fine*

Compco Corporation
2251 W. St. Paul, Chicago 47, Ill.
Lawrence H. Wrobel

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse-Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station
Chicago 38, Ill. *John A. Wright*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave., Leaside, Toronto 12, Ont.
H. L. Wright

Cutler Electrical Products, Inc.
5524 Haverford Ave.
Philadelphia 39, Pa. *David Cutler*

Cutler Light Manufacturing Co.
2026-28 N. 22nd St., Philadelphia 21, Pa.
Robert T. Cutler

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

Dazor Manufacturing Corp.
4485 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Duray Fluorescent Mfg. Company
3518 W. Montrose Ave.
Chicago 18, Ill. *Ludwig Dannenberg*

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

East Side Metal Spinning & Stamping Corp.
1501 Elizabeth Ave., W.
Linden, N. J. *M. A. Kremer*

Electrolier Mfg. Company, Ltd.
5849 Boyer St.
Montreal, Que., Canada *John Issenman*

Ender-Monarch Corp.
50 Sylvester St.
Westbury, N. Y. *Nathan Miller*

Electro Silv-A-King Corporation
1535 So. Paulina St.
Chicago 8, Ill. *C. I. Schneider*

Esty Manufacturing Company
112 S. Sangaman St.
Chicago 6, Ill. *Ben Trossman*

Fluorescent Equipment & Mfg. Co.
5105 Cowan Ave.
Cleveland 4, Ohio *Leonard S. Freeman*

Fluorescent Fixtures of Calif.
352 Shaw Road
South San Francisco, Calif. *Ernest O. Anders*

Fluores-O-Lite Co.
Evans Terminal, No. Broad St.
Hillside, N. J. *Meyer H. Silverman*

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

The Frink Corporation
27-01 Bridge Plaza North
Long Island City, N. Y. *Theo. J. Brassel, Jr.*

Fullerton Manufacturing Corp.
17 Chestnut St., South Norwalk, Conn.
Lawson Fullerton

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Ballasts Dept.
1430 E. Fairchild St.
Danville, Ill. *E. C. Schorr*

General Electric Co.
Outdoor Lighting Dept.
920 Western Ave.
West Lynn 3, Mass. *Henry Chanon*

General Lighting Products Co.
468 Frelinghuysen Ave., Newark 5, N. J.
Nathan H. Eglowstein

Gibson Manufacturing Co.
1919 Piedmont Circle N. E., Atlanta, Ga.
R. R. Gibson

(Continued on page 42A)

ONLY PLAX POLYFLEX® AND METHAFLEX® GIVE YOU ALL 8 ADVANTAGES FOR SUSPENDED CEILING PANELS

1	**CODE ACCEPTANCE** — U. L. LISTING; FACTORY MUTUAL APPROVAL
2	**DIMENSIONAL STABILITY** — TEMPERATURE AND HUMIDITY
3	**LIGHT TRANSMISSION**
4	**HIDING POWER**
5	**AGING RESISTANCE**
6	**COLOR STABILITY**
7	**DECORATIVE VERSATILITY** — (Adaptability through Forming to Varying Design Requirements)
8	**ECONOMY** — INITIAL COST; INSTALLATION COST; MAINTENANCE COST

CHECK THIS CHART FOR PROOF. Here is conclusive evidence that Plax materials give you more for your lighting dollar than other sheet plastics. Whatever your lighting plans, make sure you have the whole story on Plax Polyflex and Methaflex panels — the light weight, luminous suspended ceilings that are easy to install, low in initial cost, economical to maintain, lastingly efficient, enduringly attractive and code accepted. Please write for our brochure and test sample kit.

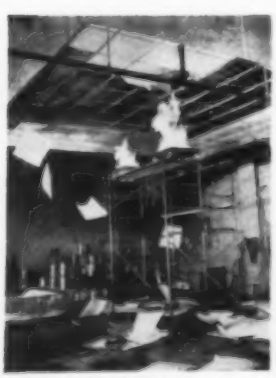
U. L. TEST CONCLUSIONS

"SPRINKLER OPERATION AND DISTRIBUTION: The ease with which the panels shrink when exposed to heat allow them to fall freely from the supporting structure thereby offering no hindrance to the discharge of water from the sprinklers."

PLAX

PLAX CORPORATION
P.O. BOX 1019, HARTFORD, CONNECTICUT

LUMINOUS CEILINGS • TROFFERS



See "U.L. Test" above.

Plax panels in hospital supply room.

Sectional ceiling with Plax panels in plant cafeteria.

POLYFLEX SHEET (Biaxially Oriented Styrene) .010" — .020"	METHAFLEX SHEET (Biaxially Oriented Acrylic) .010" — .020"	PLASTIC SHEET A .0075" — .020"	PLASTIC SHEET B .030" — .100"	PLASTIC SHEET C .050" — .125"	PLASTIC SHEET D .050" — .125"
GENERAL ACCEPTANCE	GENERAL ACCEPTANCE	GENERAL ACCEPTANCE	NOT REPORTED	LIMITED	NOT REPORTED
GENERAL ACCEPTANCE	GENERAL ACCEPTANCE	GENERAL ACCEPTANCE	NOT REPORTED	LIMITED	NOT REPORTED
HOLDS SHAPE AT TEMPERATURES FROM SUB-ZERO TO 175°F UNDER ANY HUMIDITY	HOLDS SHAPE AT TEMPERATURES FROM SUB-ZERO TO 165°F UNDER ANY HUMIDITY	HOLDS SHAPE AT TEMPERATURES FROM SUB-ZERO TO ONLY 125-145°F UNDER ANY HUMIDITY	GOOD, EXCEPT FOR 4-5% WATER ABSORPTION	HOLDS SHAPE AT TEMPERATURES FROM SUB-ZERO TO 165°F UNDER ANY HUMIDITY	HOLDS SHAPE AT TEMPERATURES FROM SUB-ZERO TO 175°F UNDER ANY HUMIDITY
MINIMUM 50% in .015" MINIMUM 45% in .020"	MINIMUM 60% in .015" MINIMUM 55% in .020"	LESS THAN 50% in .015"	UNKNOWN	CAN BE ADJUSTED BY PIGMENTATION TO BETTER THAN 60% IN THICKNESSES OF .050 AND GREATER	CAN BE ADJUSTED BY PIGMENTATION TO BETTER THAN 50% IN THICKNESSES OF .050 AND GREATER
EXCELLENT even at 1½" from fluorescent lamp	EXCELLENT even at 1½" from fluorescent lamp	EXCELLENT — at 8" or more from fluorescent lamp	GOOD	EXCELLENT — at 8" or more from fluorescent lamp	EXCELLENT — at 8" or more from fluorescent lamp
EXCELLENT — NO AGE EMBRITTLEMENT	EXCELLENT — NO AGE EMBRITTLEMENT	LOSES STRENGTH BECOMES BRITTLE	GOOD	EXCELLENT	GOOD TO EXCELLENT
EXCELLENT	EXCELLENT	DISCOLORS WITH AGING	DISCOLORS WITH AGING	EXCELLENT	GOOD TO EXCELLENT
EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT
LOW	MODERATE	LOW	MODERATE	HIGH	MODERATE
LOW — Lightweight Grids or Suspensions	LOW — Lightweight Grids or Suspensions	LOW — Lightweight Grids or Suspensions	MODERATE	HIGH — Weight of Panels Requires Strong Suspension	HIGH — Weight of Panels Requires Strong Suspension
LOW — Lightweight, Smooth, Rigid Panels, Easy to Handle and Clean.	LOW — Lightweight, Smooth, Rigid Panels, Easy to Handle and Clean.	MODERATE — Difficult to Handle in Other than Panel Form. Matte Finish Adds to Cleaning Costs.	MODERATE — Heavy Panels Slow Removal and Replacement	HIGH — Greater Panel Weight Increases Handling and Cleaning Time — Breakage.	HIGH — Greater Panel Weight Increases Handling and Cleaning Time — Breakage.

FIXTURES • SECTIONAL LIGHTING

Before and after pictures show how Plax panels hide pipes, sprinklers, and ducts.

Sustaining Members — Lighting Equipment Manufacturers

(Continued from page 39A)

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Great Northern Mfg. Corporation
4221 Harrison St.
Chicago, Ill. *D. J. Epp*

Grimes Manufacturing Co.
515 No. Russell St., Urbana, Ohio *L. B. Moore*

Guardian Light Company Inc.
500 North Blvd., Oak Park, Ill. *W. S. Akely*

The Edwin F. Guth Co.
2615 Washington Ave.
St. Louis 3, Mo. *Fred E. Guth*

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Holophane Company, Limited
150 The Queensway, Toronto 14, Ont.
Canada. *Frank T. Groome*

House-O-Lite Corporation
2430 S. Ashland Ave., Chicago 8, Ill.
Jack R. Stone

Hubbard and Company
6301 Butler St., Pittsburgh 1, Pa. *C. C. Warne, Jr.*

Ideal Industries, Inc.
1000 Park Ave.
Sycamore, Ill. *G. B. Koch*

Illuminating Engineering Co.
2347 E. Nine Mile Road
Hazel Park, Mich. *Bert C. Pretzer*

Jefferson Electric Co.
Bellwood, Ill. *W. C. Anderson*

Joleco Corporation
2513 Baldwin St.
St. Louis, Mo. *George Ledbetter*

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 South Morgan St.
Chicago 9, Ill. *J. H. Fahey*

The Kayline Company
2480 E. 22d St.
Cleveland 15, Ohio *M. A. Eskins*

Keystone Electric Manufacturing Co.
2228-36 E. Tioga St.
Philadelphia 34, Pa. *Leonard M. Siegel*

Kirchmer Bros. Mfg. Co.
2146 Newhouse Ave.
St. Louis 7, Mo. *A. W. Kirchmer*

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Light Control Co.
2333 East Olympic Blvd.
Los Angeles 21, Calif. *Stanley E. Lindahl*

Lighting Products, Inc.
2259 W. Park Ave.
Highland Park, Ill. *Joseph A. Schneller*

Line Material Co., Division of McGraw Electric Co.
800 North 8th St.
Milwaukee 1, Wis. *M. C. Harsh*

Litecontrol Corp.
56 Pleasant St.
Watertown 72, Mass. *Lawrence E. Brown*

Litecraft Manufacturing Corp.
8 East 36th St., New York 16, N. Y. *Ben Roisman*

Lithonia Lighting Products Co., Inc.
Lithonia, Ga. *Robert J. Freeman*

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

Luminous Ceilings Inc.
2500 West North Ave., Chicago 47, Ill.
Louis Rosenstein

Major Equipment Company Inc.
4603-19 Fullerton Ave.
Chicago, Ill. *Ross O. Major*

Marlou Lights, Inc.
60 South Ave.
Fanwood, N. J. *W. F. Calcagno*

Marvin Manufacturing Co.
648 Santa Fe
Los Angeles, Calif. *Carl O. Anderson*

Metalcraft Products Co., Inc.
Mascher & Lippincott Sts.
Philadelphia 33, Pa. *Fred M. Pyle*

Midwest Chandelier Co.
15th & Gentry Sts.
No. Kansas City 16, Mo. *Sidney Lefkovitz*

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mitchell Manufacturing Company
2525 Clybourn Ave.
Chicago 14, Ill. *George Kielty*

Mitchell Manufacturing Co., Ltd.
19 Waterman Ave.
Toronto 13, Ont. *J. E. Landers*

Modern Light Company
7809 Industrial Court
Maplewood 17, Mo. *Edwin L. Ehret*

Modern Light & Equipment Co.
3812 S. Wabash Ave.
Chicago, Ill. *M. L. Offenberg*

Morlite Equipment Co.
P. O. Box 106, Girard, Pa. *Finley J. Gordon*

Multi Electric Mfg. Co.
4223-43 West Lake St.
Chicago, Ill. *Leo J. McDonald*

Nepo Mfg. Co.
6025 N. Keystone Ave.
Chicago 30, Ill. *N. E. Passman*

Northern Light Company
1657 No. Water St., Milwaukee 2, Wis.
Fred Cramer

Peerless Electric Limited
5585 Fullum, Montreal 36, Que. *L. A. Van Duzer*

The Perfecilte Company
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, Jr.

Philadelphia Electrical & Mfg. Co.
1228-36 N. 31st St.
Philadelphia 21, Pa. *R. A. Manwaring*

Pittsburgh Reflector Co.
405-411 Oliver Bldg.
Pittsburgh 22, Pa. *H. C. Zinsmeister*

Powerlite Devices, Limited
1870 Davenport Rd.
Toronto 9, Ont. *M. B. Hastings*

Prescolite Manufacturing Corp.
2229 Fourth St.
Berkeley 10, Calif. *W. D. Runswick*

Pryne & Co., Inc.
P.O. Box 698, Pomona, Calif. *Roger W. Holston*

Pyle National Company
1334 N. Kostner
Chicago 51, Ill. *A. G. Voelkner*

Quadrangle Mfg. Co.
32 So. Peoria St., Chicago 7, Ill. *J. D. Auckland*

Quaker City Electric Mfg. Co.
2810 East Pacific St.
Philadelphia, Pa. *Reuben Haberman*

Rambusch Decorating Co.
40 W. 13th St.
New York 19, N. Y. *Edward Rambusch*

Revere Electric Mfg. Co.
6009-17 N. Broadway
Chicago 40, Ill. *Murray J. Whitfield*

Rosemont Industries, Limited
2090 Moreau St.
Montreal, Que., Canada *Paul A. Ducasse*

Ruby-Philite Corp.
32-02 Queens Blvd.
Long Island City 1, N. Y. *Louis Phillips*

The Safety Car Heating & Lighting Co.
P. O. Box 70, Milford, Conn. *H. W. Jones*

Shalda Manufacturing Co., Inc.
156 W. Providence, Burbank, Calif.
William Shalda

Silvray Lighting, Inc.
R.K.O. Bldg., Radio City, New York 20, N. Y.
J. M. Gilbert

Smithcraft Lighting Division
A. L. Smith Iron Company
217 Everett Ave., Chelsea 50, Mass.
Hugh M. Nazor

Smoot-Holman Co.
321 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

Sola Electric Co.
4633 W. 16th St., Chicago 50, Ill. *L. C. Marschall*

Solar Light Mfg. Co.
400 N. Ashland Ave.
Chicago 22, Ill. *Bernard Lazerson*

Solux Corporation
58-17 28th Avenue, Woodside 77
Long Island, N. Y. *A. E. Spinetta*

Southern Lighting Mfg. Co.
501 Elwell St., Orlando, Fla. *Max K. Aulick*

Stanley Electric Mfg. Co.
3700 S. 80th St., Philadelphia, Pa.
Bernard S. Heller

Steber Manufacturing Co.
2700 Roosevelt Rd., Broadview
Maywood, Ill. *Robert J. Besal*

Sterling Reflector & Mfg. Co.
3249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Stonco Electric Products Co.
333 Monroe Ave., Kenilworth, N. J. *H. W. Spence*

Sunbeam Lighting Co.
777 E. 14th Place, Los Angeles 11, Calif.
Herbert L. Krieger

Sun-Lite Manufacturing Co.
2555 Bellevue Ave., Detroit 7, Mich. *Fred Binder*

Sun-Ray Fluorescent Co.
2025 South Michigan Ave, Chicago, Ill.
Jerome Gimbal

Supreme Lighting Company
600 Turner St.
Los Angeles 12, Calif. *J. Shapiro*

Thompson Electric Co.
1111 Power Ave.
Cleveland 14, Ohio *Robert K. Farrington*

Tri-Part Mfg. Company
934 Plum Street
Detroit 1, Mich. *Julius Reznik*

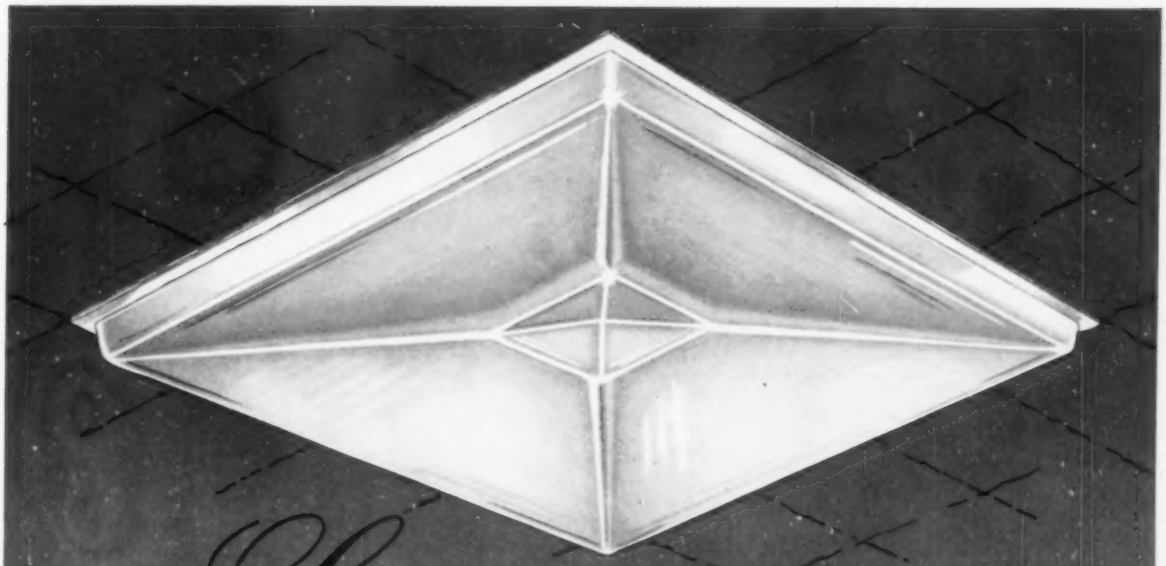
Unistrut Corp.
4118 Monroe Ave.
Wayne, Mich. *Hugo E. Rebentisch*

Unistrut Products Company
1015 W. Washington Blvd.
Chicago 7, Ill. *George W. Butler*

Voigt Company
1636-38 N. Carlisle St., Philadelphia 21, Pa.
C. J. Frank

The Wakefield Co.
Vermilion, Ohio *A. F. Wakefield*

(Continued on page 44A)



for *Luxury* lighting...

GARCY 5600 Series

Recessed Luminaires

featuring one-piece plastic shield
in 2′ x 2′, 2′ x 4′ and 4′ x 4′ units

In this series Garcy offers the highest quality lighting with a choice of three types of shielding . . . all in hinged frames:

Plexiglas shield—The unique die-formed contour gives uniform low brightness and provides the rigidity which permits a one-piece diffuser to be used even in the large 4′ x 4′ unit.

Louver shield—Lightweight, completely framed and tab-locked into a one-piece assembly for convenient maintenance, superior appearance and greater durability.

Glass shield—Standard is Corning Alba-Lite, fine-ribbed translucent opal glass, an excellent diffusing medium. Other types of glass are available as desired.

Sturdy, rigid frames provide secure mounting, and are designed to prevent light leaks around edges.

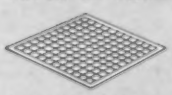
GARCY ... *established 1898*
... *contributing to 50 years of lighting progress*

Garden City Plating & Mfg. Co., 1760 N. Ashland Ave., Chicago 22, Ill.
In Canada: Garcy Co. of Canada, Ltd., 191 Niagara St., Toronto

SUSTAINING MEMBER

THREE TYPES OF SHIELDING

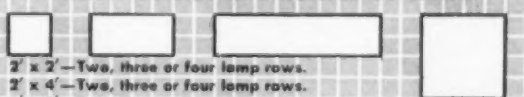
Plastic panel in hinged frame



Hinged one-piece louver

Glass panel in hinged frame

VARIETY IN SIZE AND NUMBER OF LAMPS



2′ x 2′—Two, three or four lamp rows.
2′ x 4′—Two, three or four lamp rows.
2′ x 8′—Two, three or four lamp rows.
4′ x 4′—Six, eight or ten lamp rows.
Choice of rapid start fluorescent or slimline lamps.

Sustaining Members — Lighting Equipment Manufacturers

(Continued from page 42A)

Webb Electric Mfg. Company
1701 S. W. Jefferson St., Portland 1, Ore.
F. E. Webb

Welsbach Engineering and Management Corp.
1500 Walnut St.
Philadelphia 2, Pa. *H. H. Adams*

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 2, Ohio
(P. O. Box 5817) *E. C. Huerkamp*

Wheeler Reflector Co.
275 Congress St.
Boston 10, Mass. *Harlan B. Fletcher*

R. & W. Wiley, Inc.
119 Dearborn St.
Buffalo 7, N. Y. *Robert C. Graves*

H. E. Williams Products Co.
108 S. Main St., Carthage, Mo. *F. B. Williams, Jr.*

Wilmot Castle Co.
1255 University Ave.
Rochester 7, N. Y. *E. H. Greppin*

J. A. Wilson Lighting & Display Ltd.
280 Lakeshore Rd., Toronto, Ont. *J. A. Wilson*

The Wiremold Company
Hartford 10, Conn. *Robert H. Murphy*

LAMP MANUFACTURERS

Canadian General Electric Co., Ltd. Lamp Division
165 Dufferin St., Toronto, Ont. *E. H. Lindsay*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Duro Test Corp.
2321 Hudson Blvd.
North Bergen, N. J. *James L. Cox*

General Electric Co., Lamp Dept.
Nela Park
Cleveland 12, Ohio *Willard C. Brown*

Sylvania Electric Products Inc.
1740 Broadway
New York 19, N. Y. *D. P. Gaverly*

Sylvania Electric (Canada) Ltd.
Suite 522, University Tower Bldg.
Montreal, Que., Canada *F. W. Fulle*

Westinghouse Lamp Div.
Bloomfield, N. J. *Marshall N. Waterman*

RESIDENTIAL LIGHTING EQUIPMENT MANUFACTURERS

Colonial Premier Corp.
466 W. Superior St.
Chicago 10, Ill. *M. H. Dottenheim*

H. A. Framburg & Co.
3320-28 Carroll Ave.
Chicago 24, Ill. *Stanley A. Framburg*

Globe Lighting Products Co., Inc.
1710 Flushing Ave.
Brooklyn 6, N. Y. *Isidor Rosenblatt*

Jewel Electric Products, Inc.
266 Glenwood Ave.
Bloomfield, N. J. *Joseph G. Wares*

Lightolier Co.
11 East 36th St.
New York 16, N. Y. *H. Stollnitz*

Luxor Lighting Products Inc.
Empire State Building
New York, N. Y. *Sergei Marketan*

Moe Light, Inc.
410 So. Third St.
Louisville 2, Ky. *Frank Marriett*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg.
New York 1, N. Y. *Morris Thau*

John C. Virden Co.
6009-6103 Longfellow Ave.
Cleveland 3, Ohio *John C. Virden, Jr.*

John C. Virden, Ltd.
19 Curity Ave., Toronto, Ont. *P. G. Kirkpatrick*

LIGHTING EQUIPMENT DISTRIBUTORS AND CONTRACTORS

Black & McDonald Limited
200 King Street W., Toronto, Ont., Canada.
W. J. McDonald

Canadian Westinghouse Supply Co. Ltd.
195 Fleet St. E.
Toronto, Ont., Canada *S. W. McKnight*

Capitol Light & Supply Co.
6-8 Huntley Place
Hartford, Conn. *Arnold S. Cartin*

Efengee Electrical Supply Co.
949 W. Chicago Ave., Chicago 22, Ill. *Lee Mirus*

Electric Supply Corporation
701 W. Jackson Blvd.
Chicago 6, Ill. *Peter V. Polton*

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill. *Ray O'Leary*

Enterprise Electric Co.
6507 Euclid Ave., Cleveland, Ohio *William S. Fell*

W. Freeman & Son Ltd.
275 Woodland Drive
Vancouver, B. C., Canada *A. Freeman*

General Electric Supply Company
A Division of General Electric Distributing Corp.
1260 Boston Ave., Bridgeport 9, Conn.
W. W. Booth

Graybar Electric Co., Inc.
420 Lexington Ave.
New York 17, N. Y. *Raymond C. Kinney*

Hawkins Electric Co.
1447 Washington Blvd.
Chicago 7, Ill. *R. R. Hill*

Hecker and Co., Inc.
59 W. Marquette Road
Chicago 21, Ill. *W. E. Froh*

Jeryl Lighting Products, Inc.
42 W. Cermak Road
Chicago, Ill. *Chas. Meyerson*

Kelso-Burnett Electric Co.
223 W. Jackson Blvd.
Chicago 6, Ill. *Sigmund A. Hollinger*

Main Electric Company
741 Milwaukee Ave., Chicago, Ill.
William Kamin

Malloy-Robinson Co.
1701 S.W. Jefferson Street
Portland, Ore. *Geo. A. Robinson*

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Que. *Henri Martineau*

Meade Electric Company, Inc.
5401-15 W. Harrison St.
Chicago 44, Ill. *Henry E. Burkhardt*

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill. *Fred Pedrigi*

Monroe Electric Co.
157 W. Ontario St., Chicago 10, Ill. *Albert Kahn*

Northern Electric Co., Ltd.
1600 Notre Dame St., West
Montreal, Que., Canada *A. G. V. Smith*

Pierce Electric Co.
367 W. Adams St., Chicago 6, Ill. *John H. Pierce*

Portland Electric & Plumbing
905 S. W. 16th Avenue
Portland 5, Ore. *Ned Higgins*

Revere Electric Supply Company
2501 W. Washington Blvd.
Chicago 12, Ill. *Arthur Peterson*

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa. *T. W. Lauer*

Service Electric Co.
8345 South Ashland, Chicago, Ill. *Harold Zwitt*

The Starbuck Sprague Co.
39 Spring St.
Waterbury, Conn. *E. A. Madison*

Stubbs Electric Co.
33 N. W. Park Avenue
Portland 9, Ore. *Richard M. Boynton*

Super Electric Construction Co.
4300 W. Chicago Ave., Chicago 51, Ill.
P. M. Pavesich

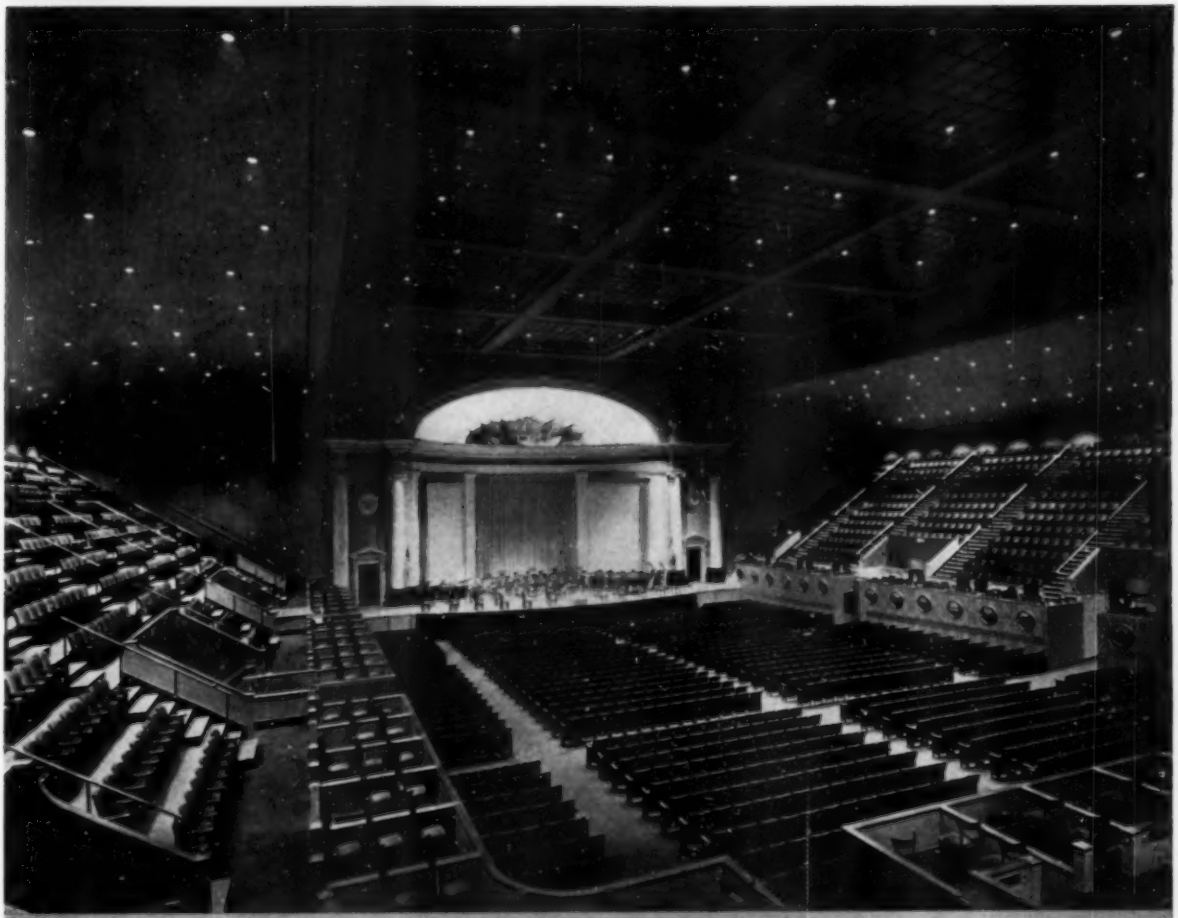
Frank C. Teal Co.
3222-24 E. Jefferson, Detroit 7, Mich.
Harold C. Smith

Terreau-Racine Ltee.
196-228 St. Paul St.
Quebec, Que., Canada *Paul Ducasse*

Warren Electric Co.
P.O. Box 2594, Houston, Texas *J. R. Thompson*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill. *B. H. Boatner*

(Continued on page 58A)



Constitution Hall, Washington, D. C.

(DAUGHTERS OF THE AMERICAN REVOLUTION)

•

RELIGHTED BY RAMBUSCH UNDER THE SUPERVISION OF
BERNARD LYON FRISHMAN & ASSOCIATES, *Architects* • L. WARREN BOGAN & ASSOCIATES, *Consulting Engineers*

When it comes to lighting large and lofty interiors the Rambusch Downlite has no equal. It is efficient, safe, economical, simple to maintain, glare shielded and guaranteed to produce the promised results. • There are 100 Rambusch lighting representatives in the country—one of them is near you and anxious to serve you.

RAMBUSCH DESIGNERS • MANUFACTURERS
40 WEST 13th STREET, NEW YORK 11, N. Y.

General Electric salutes a half century of I.E.S. progress, reports to the profession on new, high efficiency lamps

By a happy coincidence the 50th Anniversary of the Illuminating Engineering Society comes at a time when a new era in lamp making is beginning.

This new era opens with several remarkable improvements in lamp efficiency. Thanks to the accumulated know-how of the IES these improvements can be translated quickly into large savings for consumers.

Chief among the most recent developments is the new axial filament construction. This new filament will bring increases of as much as 15% in light output for incandescent lamps of 300-watts and larger. Within a few years this development will be incorporated in all incandescent lamps used for general lighting.

On the following pages, the General Electric Company reports on this and several other outstanding lamp developments announced recently. These developments and the lore that illuminating engineers can bring to their application will help usher in a new era in lighting.

Good lighting is fundamental to modern industrial and human progress. Good lamps are the tools that engineers use to provide the good lighting essential to good living. It is therefore, with pride that we point to our efforts in putting better tools in the hands of men who know how to use them.

Progress Is Our Most Important Product

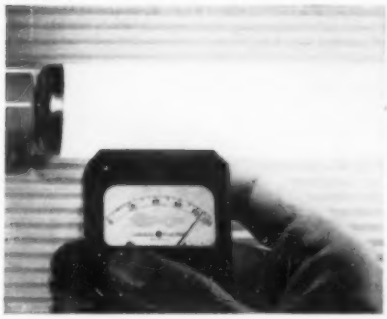
GENERAL ELECTRIC

GOLDEN ANNIVERSARY I·E·S 1906 1956

SUSTAINING MEMBER

Revolutionary stand-up filament —gives 15% more light.

World's most powerful fluorescent gets more powerful.



Coiling a coil, then coiling it again helps save twice lamp cost.

GENERAL ELECTRIC

Lamps for 1956

General Electric reports on basic new developments in lamps that will affect business costs in the coming year

The most important function of a lamp bulb is to convert electricity into light economically. You buy lamp bulbs to get *light*. Typically you spend almost nine times as much for electricity and maintenance labor as you do for the lamp bulb itself. Thus a 10% improvement in lamp performance is worth many times as much as a 10% saving in lamp cost.

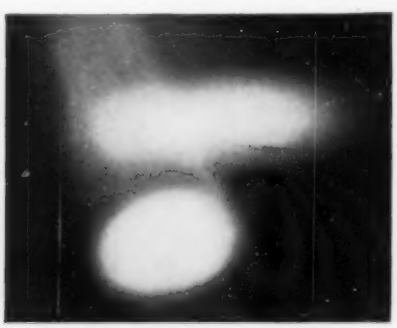
That's why General Electric works to improve existing lamps and to design new lamps that give still higher efficiency, reduce maintenance costs, or improve appearance by better color or more modern design. It's the surest way to give you more for *all* your lighting dollars.

Since early 1950, General Electric has put more than 750 new lamps on the market. These lamps give you more light per dollar . . . reduce your maintenance costs . . . and do important new jobs. Over one-third of the dollars spent in 1955 for G-E large lamps were for lamps that General Electric introduced in the past ten years.

This continuous progress has paid you dividends worth several times your yearly lamp costs. That's why since Thomas Edison's first electric lamp, it has been the policy of General Electric to re-invest a substantial part of net receipts into the search for new lamps. The following pages show some of the more recent fruits of that research. At least one of these lamps can reduce your lighting costs in 1956.

Phosphor lining in mercury lamps produces color-improved light.

World's highest concentration of infra-red energy.



New versatility for your spot and flood lighting needs.

GENERAL ELECTRIC

Lamps for 1956

New General Electric discovery uses revolutionary stand-up filament to give you 15% more light from a bulb

"Bonus Line"...$100,000,000 Yearly Light Bonus for America

General Electric announces the most important development in light bulb filaments in 42 years—a filament that stands on end. It gives up to 15% more light at no increase in cost to you for current consumed.

This new development is available now in the 750- and 1000-watt Bonus Line G-E Lamps at no increase in price. The 500-watt size is also available at a somewhat higher price. Other sizes from 50 to 300-watts are being redesigned to use the new stand-up or axial filament.

The new line of G-E incandescent bulbs incorporating the new filament is called the G-E Bonus Line. The value of the light bonus they will ultimately deliver is estimated at over $100,000,000 a year.

Four Years of Research

At present most light bulb filaments are placed crosswise in the bulb. Four years of intensive research were required to solve the technical problems involved in changing to an axial position.

The light gain achieved by the new axial positioning is a minimum of 6%. The new positioning also makes it practical—for the first time—to use a specially designed coiled-coil filament in bulbs of 300 watts and over. In these larger bulbs, the two improvements combine to bring the light increase to 15% during the life of the bulb *—extra light worth more than the entire purchase price of the bulb itself!*

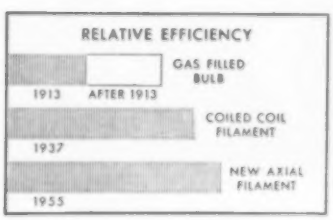


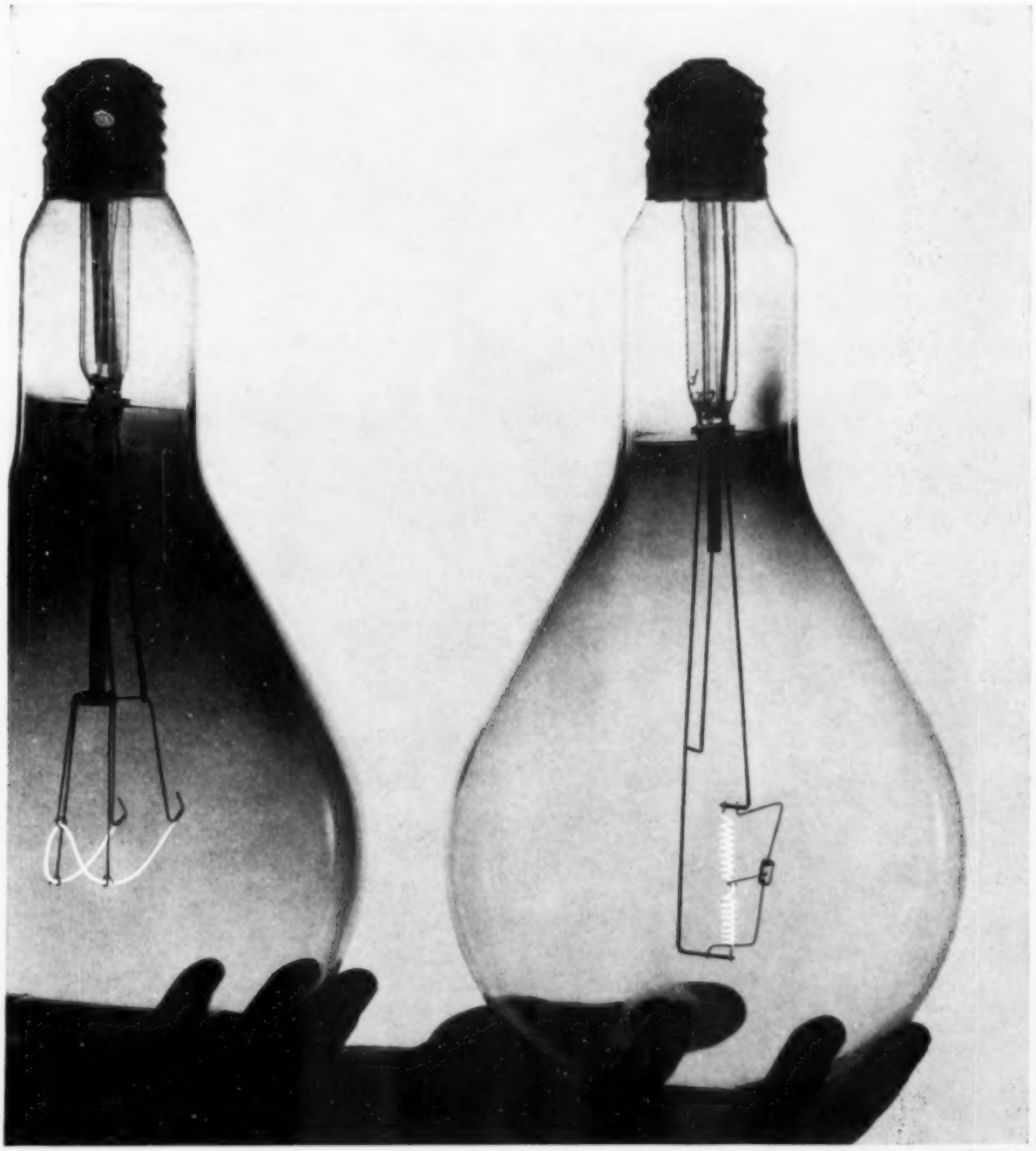
Chart shows how three principal filament improvements in last 42 years have boosted light output.

MORE EXAMPLES OF

THE NEW STAND-UP FILAMENT, *right, increases light output in two ways. First, the hotter a filament burns the more light it gives, and the axial position allows the filament to burn hotter without burning out any sooner.*

Second, the effect of bulb blackening on light output is cut to a minimum. Deposits from the G-E axial filament are concentrated in the stem of the bulb when it burns base up, or in a small spot at the opposite end when burned base down—places where it least interferes with the light output.

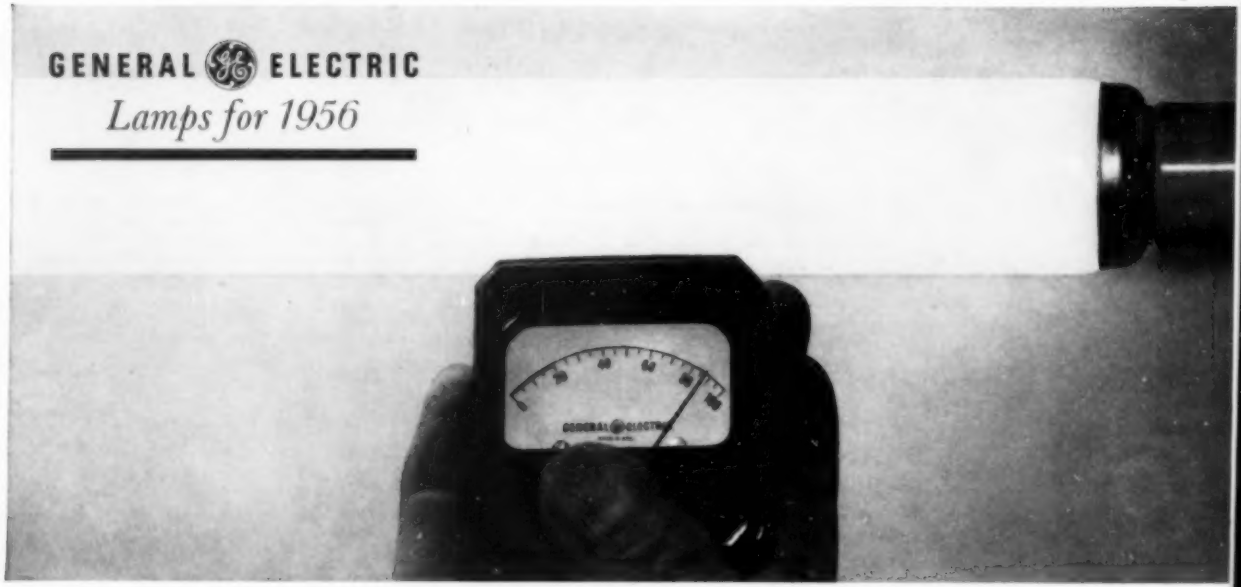
(Picture taken near end of bulb life.)



HOW GENERAL ELECTRIC LAMPS GIVE YOU MORE FOR ALL YOUR LIGHTING DOLLARS, ARE SHOWN ON THE FOLLOWING PAGES ⇨

GENERAL ELECTRIC

Lamps for 1956



General Electric high output fluorescent, world's most powerful, gets still more powerful

When General Electric announced the High Output lamp in 1954, it was the most powerful fluorescent lamp in the world. Besides giving users a third more light than any other fluorescent lamp, it starts smoothly without starters. It fits securely in rugged push-pull sockets and is easy to service.

7% MORE LIGHT IN THE HIGH OUTPUT LAMP was achieved in 1955 by General Electric engineers.

Performance gains in present G-E lamps worth twice the lamp price

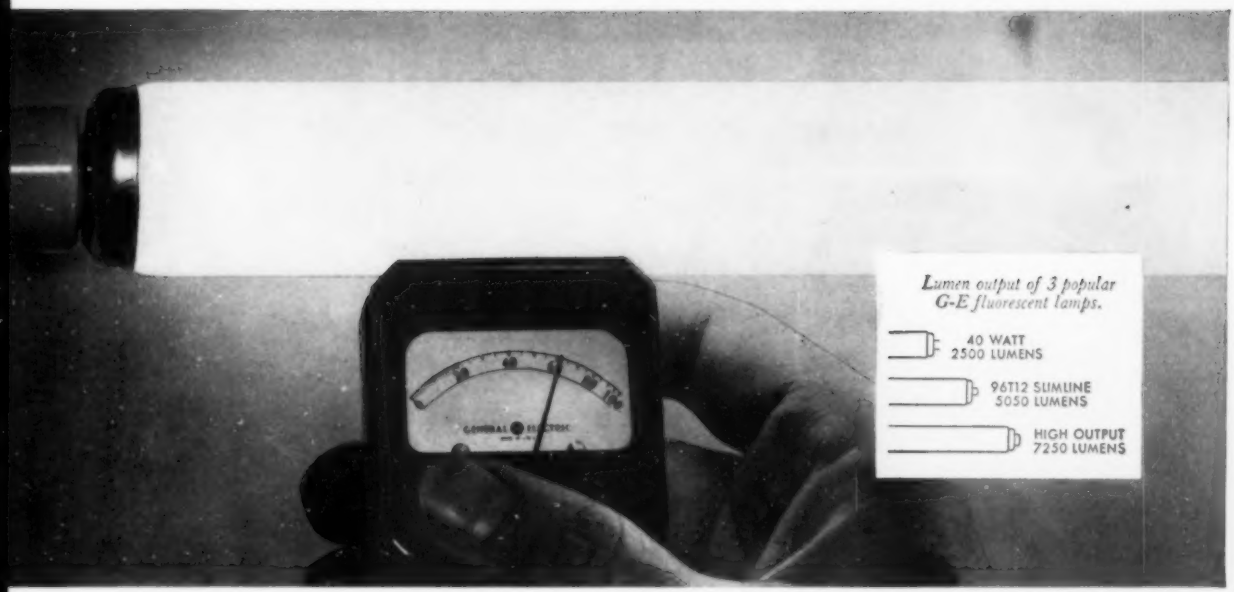
The two most widely used fluorescent lamps are the four-foot 40-watt (40T12) and the eight-foot Slimline (96T12). Both have been steadily improved through G-E research. Two major improvements are shown in the photo at left. The glowing phosphors silhouette the tiny cathode which is the heart of the lamp.

MORE LIGHT. Since early 1950, these two lamp types have averaged gains of about 6% a year. The 40-watt lamp now gives 29% more light over its life, and the slimline 31% more.

BETTER LIFE. Published life of G-E slimlines was increased 25% three years ago. It is now equal to the 40-watt . . . the published range is from 7,500 to 18,500 hours depending on burning hours per start.

UNIFORMITY OF LIFE is better, too. There are fewer early burnouts. Tests show that 99 of 100 of these lamps will last over a year in single-shift use (2500 hours) and that 98 of 100 lamps will last over a year in double-shift use (4000 hours).

LOWER COST. About a year ago the price of both lamps was reduced by General Electric. The 40-watt lamp is 4¢ lower and the slimline 17¢ lower to case quantity buyers.



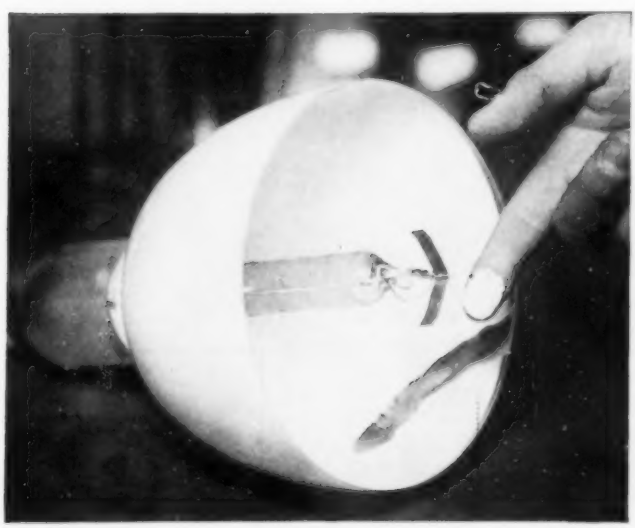
The light meters show the improved High Output fluorescent lamp, left, gives 40% more light than the regular slimline fluorescent.

The design changes that made this stepped-up light output possible also made the lamp ideal for outdoor use. It gives more light at freezing temperatures, yet starts easily, and uses lower cost ballasts and sockets.

2 NEW COLORS AND 2 NEW SIZES, were marketed in 1955. The 8-foot lamp is now available in DeLuxe Cool White and DeLuxe Warm White. Relighted stores and offices can now get more flattering light without installing extra fixtures . . . because DeLuxe High Output Lamps give as much light *with improved color* as any other 8-foot lamps without it.

G-E High Output lamps are also now available in four- and six-foot sizes to allow maximum flexibility in lighting layout.

Double duty phosphor lining makes General Electric 400-watt RC-1 today's best mercury buy



A fluorescent phosphor lining now works two ways to give you the best mercury lighting.

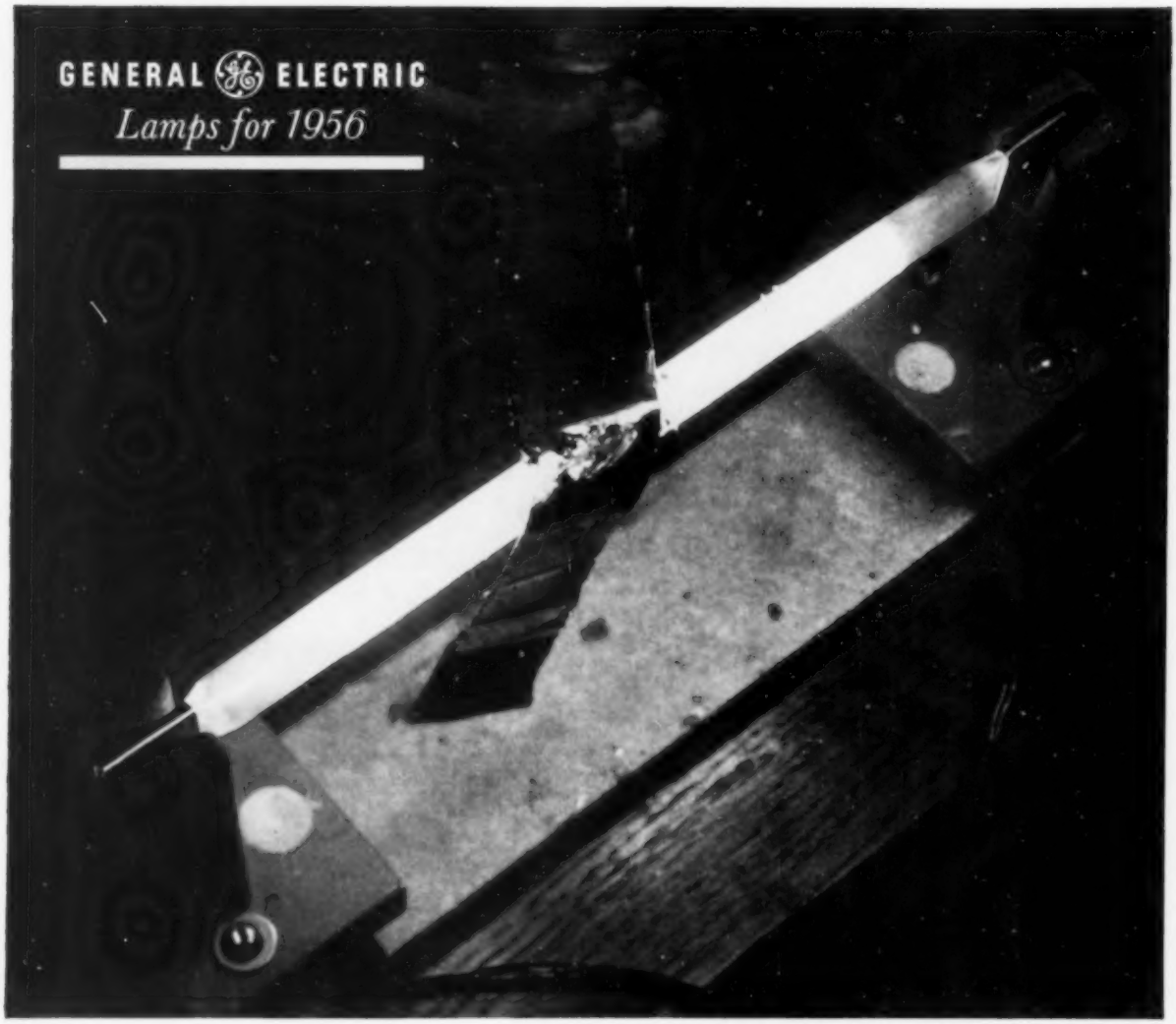
ACTS AS REFLECTOR. The white phosphor directs about two-thirds of the light downward. Because it is sealed in, it can't gather dirt or dust that would materially reduce efficiency. The other third of the light is redirected by the fixture.

IT IMPROVES COLOR. The phosphor also converts invisible radiation from the mercury arc into red light. This mixes with the mercury light to give better color than any other mercury lamp.

THE RC-1 BECAME THE BEST BARGAIN for most indoor mercury lighting when General Electric announced in 1955, a total gain of 15% in light and a new *economic* life rating of 6000 hours.

RC-1 lamps are interchangeable in most indoor 400-watt fixtures, resulting in more light, improved color —more for your lighting dollar.

MORE ON NEXT PAGE ⇨



Shown here melting aluminum, the new G-E infra-red lamp can give as much as 1000 watts per square inch. Among the new uses of this lamp is simulating heat of supersonic flight in aircraft laboratories.

New General Electric quartz infra-red, smallest and hottest

ENERGY CONCENTRATION AND SMALL SIZE never before possible does many existing jobs better, also opens up new uses for infra-red lamps in many other fields. Where previous lamps could do the job only at the sacrifice of compactness, the new lamps do the job where space is limited. For instance, floor-model duplicating machines have been made table-top size by using the high concentrations possible with the new infra-red lamp.

DELIVERS MORE ENERGY. The new G-E quartz infra-red lamp can provide 20 times as many watts per square inch at rated voltage, compared with older types. And in special applications, energy densities of over 1000 watts per square inch have been achieved for short periods.

RUGGEDNESS. The quartz tube won't crack under thermal shock. Even ice water poured over the red-hot tube won't damage it. The tungsten filament is better supported so the lamp is less affected by rough service. Available in 5 to 50 inch lengths and from 500 to 5000 watts.

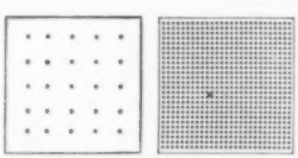


Chart shows new Quartz infra-red delivers 20 times more energy per sq. in. than the 375-watt R40.

GENERAL ELECTRIC

Lamps for 1956

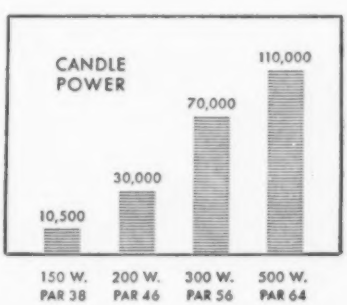
New 500-watt floods and spot broaden General Electric line of precision lamps

In 1955 General Electric added three 500-watt lamps to their already extensive line of precision reflector lamps: a wide beam flood, a medium flood and a narrow spot. The widest line yet, of optically precise lighting tools, is now available where you need accurate control of light. Whether you want to highlight small spots or flood a wider area, you can do it efficiently and at low cost with these General Electric PAR lamps.

OPTICALLY PRECISE, the G-E PAR lamps are more than ordinary light bulbs. The sealed-in reflector is accurately molded. The lens is expertly designed to form a controlled beam pattern. The filament is precisely formed and located in respect to the reflector and lens. The result is maximum light in the beam and very little "spill" light outside the beam. You have the light you need, where you need it.

FULL RANGE of spots and floods offers you a variety of beam spreads: narrow spot, spot, medium flood, and wide flood, plus a variety of wattages from 75 to 500. Candlepower ranges from 3,400 to 110,000. Whatever your needs; light for safety, light for work, light for display—there's a G-E PAR lamp for the job.

RECTANGULAR-TYPE BEAM spreads, available in the higher wattage flood lamps, are particularly well suited to many applications.



The complete line of PAR spots permits you to select the right candle power for your needs.

MORE ON NEXT PAGE ⇨

More progress is on the way at General Electric

The previous pages have shown a few ways in which General Electric lamps give you more for all your lighting dollars. New and improved lamps, that give you more of the kind of light you need, are the common sense way to reduce your lighting costs. They help you do more jobs better than ever before . . . they help you live better and work better because you can see better.

Giant strides in lamp progress look possible in the next few years. General Electric scientists are constantly at work to continue progress in all three major lamp types and all lamp sizes.

FLUORESCENT. General Electric people are unlocking the door to more-light-per-foot of lamp. Doubling the light of today's most powerful lamps, without sacrificing efficiency, now appears possible. *This will reduce your investment per unit of light and lower your operating costs.*

MERCURY. Here G-E scientists are looking forward to producing more light per lamp, and to marked gains in maintenance of light throughout life. Also to still better color.

FILAMENT. The new axial filament construction will be applied to other sizes as rapidly as possible, to extend the bonus of light they give to all users of filament lamps. Also a development program is well underway for better built-in control of light.

Stepped-up G-E research program

The search for new and better lighting tools is being stepped-up. While invention cannot be commanded or bought . . . it can be cultivated and encouraged. General Electric's Lamp Division is making the biggest investment in its history, both in people and facilities, to insure maximum lamp progress. We believe this is the most effective way we can deliver dividends on the dollars you spend for G-E lamps.

For more information about how today's lamps can be of help to you now, ask your G-E friends in your local LES chapter, or write to Large Lamp Department IE-482, General Electric Company, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

PUBLICATIONS

The Publications of the Illuminating Engineering Society listed here summarize in printed form the vast amount of research, investigation and discussion of hundreds of qualified members of the Society working on technical committees. They contain the latest available information about many aspects of the art and science of illumination, including details of application as well as the lighting techniques involved. Each publication listed here is supported by the full authority and approval of the Illuminating Engineering Society.

I.E.S. Publications are available, in single copies or in bulk, to anyone requiring knowledge of the newest in lighting application and the supporting technical information. Published prices cover only the cost of production and handling. Quantity prices vary and are lower than the single-copy prices shown in this listing. Should quantities be desired for distribution, such as for educational or promotional purposes, prices may be obtained by writing Publications Office.

Each publication is numbered for easy ordering by using the coupon on this page. Correspondence concerning publications should be addressed to: Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

(Supersedes all lists prior to January 1956)

(1) I.E.S. LIGHTING HANDBOOK, Second Edition

LATEST! One volume, 987 pages. Published 1952. Complete revision of first edition includes basic information on all phases of lighting practice and technique, based upon recently developed standards. Contains 18 technical reference and application sections; complete appendices of information regularly used; 655 photos, drawings, lighting tables, charts; fully cross-indexed . . . over 4500 items. For use of lighting engineers and specialists, consultants, architects, designers . . . all who plan, install and manufacture lighting systems and equipment.

$8.00 per copy; $6.40 in lots of ten or more. Add 50c for shipment abroad. *I.E.S. Members are entitled to one copy of the Handbook at $5.50 unless previously ordered.*

I.E.S. RECOMMENDED LIGHTING PRACTICES

These booklets are the complete, standard recommendations for lighting the prescribed areas, and are among the most comprehensive and important of all Society publications. As indicated, some of these recommendations are the work of committees of the American Standards Association, with collaboration by appropriate committees of the I.E.S. All have the approval of the Council of the Illuminating Engineering Society, and are the latest official I.E.S. recommendations.

In general, the information contained in these Recommended Lighting Practices covers completely the area shown in the title. Included in the data are suggested types of lighting systems and luminaires; levels for general lighting and for specific areas; analyses of seeing tasks; and other information essential to lighting the area and of value to lighting engineers and specialists, architects, construction people and others. Each practice is fully illustrated with charts and photographs.

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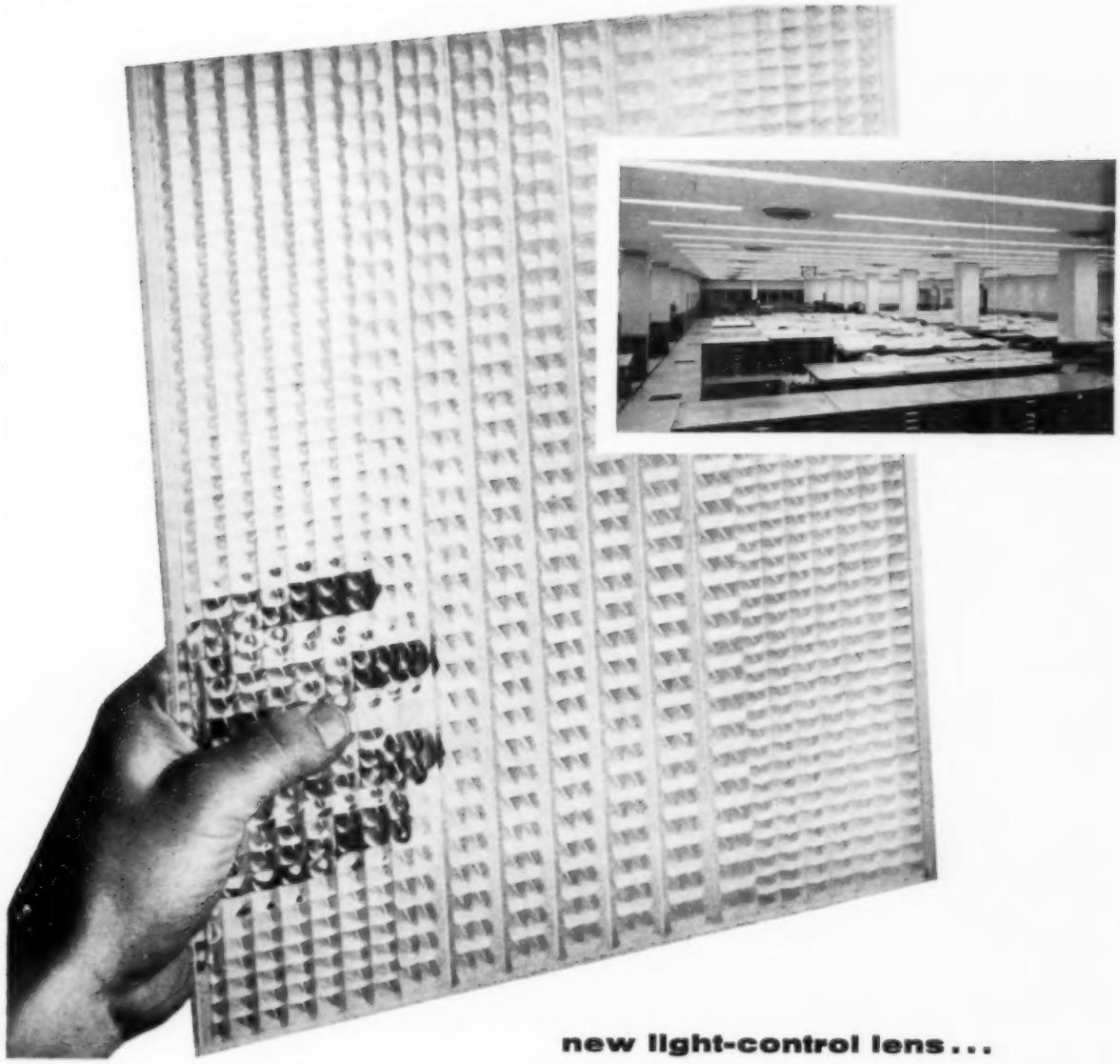
Southwestern	Fort Worth, Texas Hilton Hotel	April 8-10
South Pacific Coast	San Francisco, California Mark Hopkins Hotel	April 11-13
Pacific Northwest	Spokane, Washington Davenport Hotel	April 19-21
Inter-Mountain	Salt Lake City, Utah Utah Hotel	April 26-28
Great Lakes	Toledo, Ohio	May 7-8
Midwestern	Indianapolis, Indiana Severin Hotel	May 10-11
Canadian	Quebec, Quebec Chateau Frontenac	May 17-18
East Central	Washington, D. C. Shoreham Hotel	May 24-25



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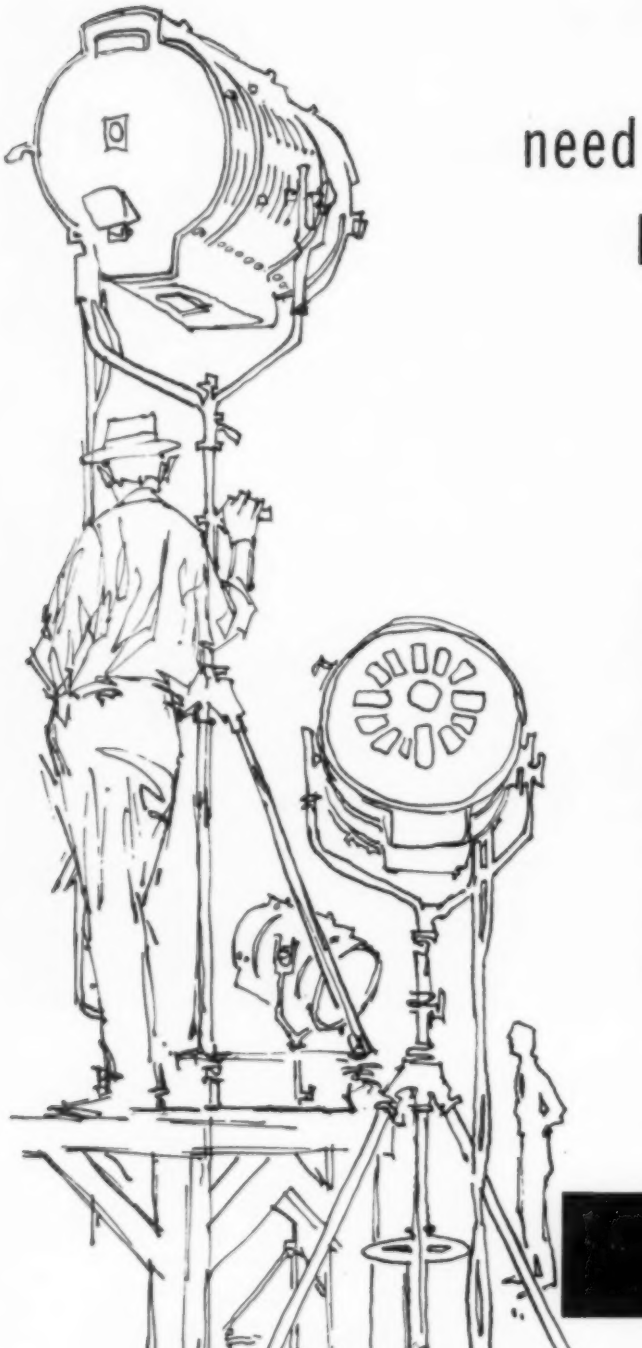

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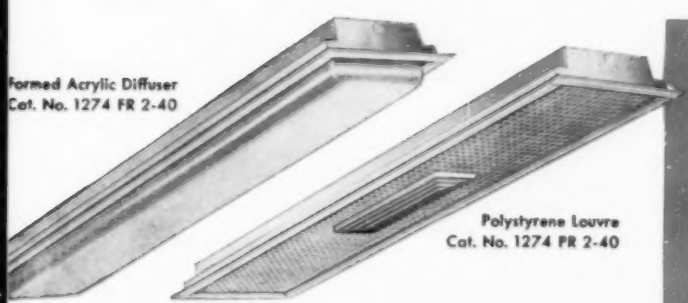

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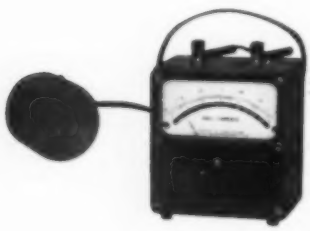

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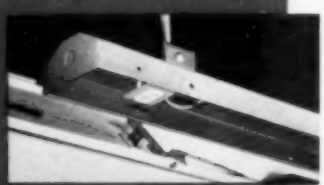
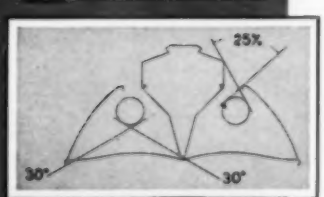


Here socket and whole fixture automatically seats when closed. In this position the lighting unit is dead.



Self-shielding. 65.2% efficiency. 25% up light. 2% shielding.

- **SAVES ON CONDUIT, RECEPTACLES, ACCESSORIES**
- **ELIMINATES ALIGNING EXTRAS, Y CHAINS, CORDS AND PLUGS**

The exclusive features of the Gibson Ortho-88 make it possible to enjoy superior industrial lighting at the cost of ordinary installations.

The Uni-Race, to which units are later attached, is easily assembled into sections up to 24 feet long and wired completely *on the floor*, except for final service connection. It is raised and hung as a unit—directly to bar joists, beams or stems. Alignment and spacing for fixtures is automatic.

The Uni-Race provides power for temporary lighting and tools. When the building is ready for occupancy, spotless fixtures can be snapped into place by two men, without tools, at the rate of 45 to 55 units per hour—in continuous rows or at intervals of 4, 8, 12 or more feet. Spacing can be changed, more units added, repairs made—all without interrupting service to other fixtures on the circuit, or additional electrical work.

The result is a top-quality installation with savings on materials and labor up to 50%.

Get all the facts in our Ortho-88 bulletin, which we'll gladly send on request, and you'll see why it pays to use the Ortho-88.

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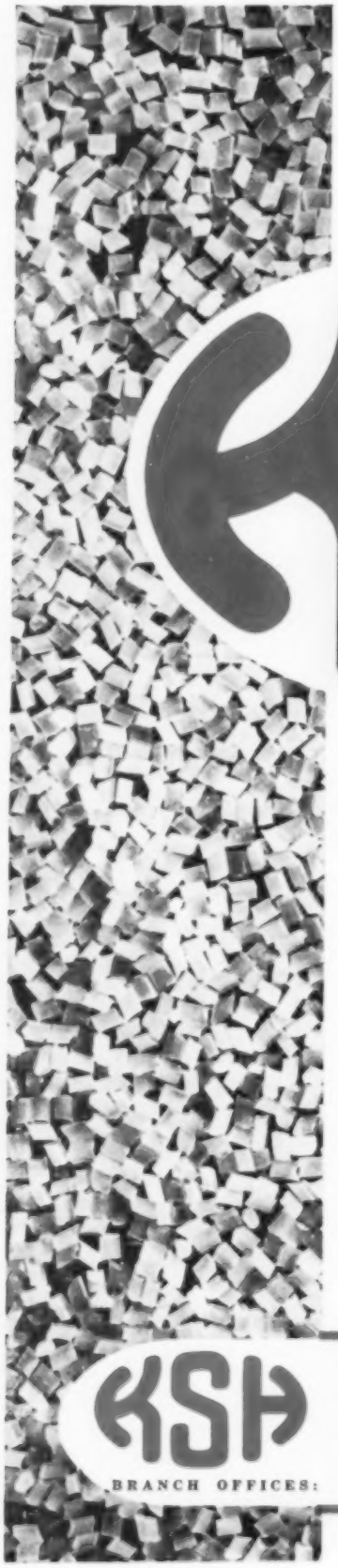

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a symbol of quality plastic extrusions in the lighting industry

HIGHEST QUALITY VIRGIN MATERIALS assure maximum physical properties and light stability.

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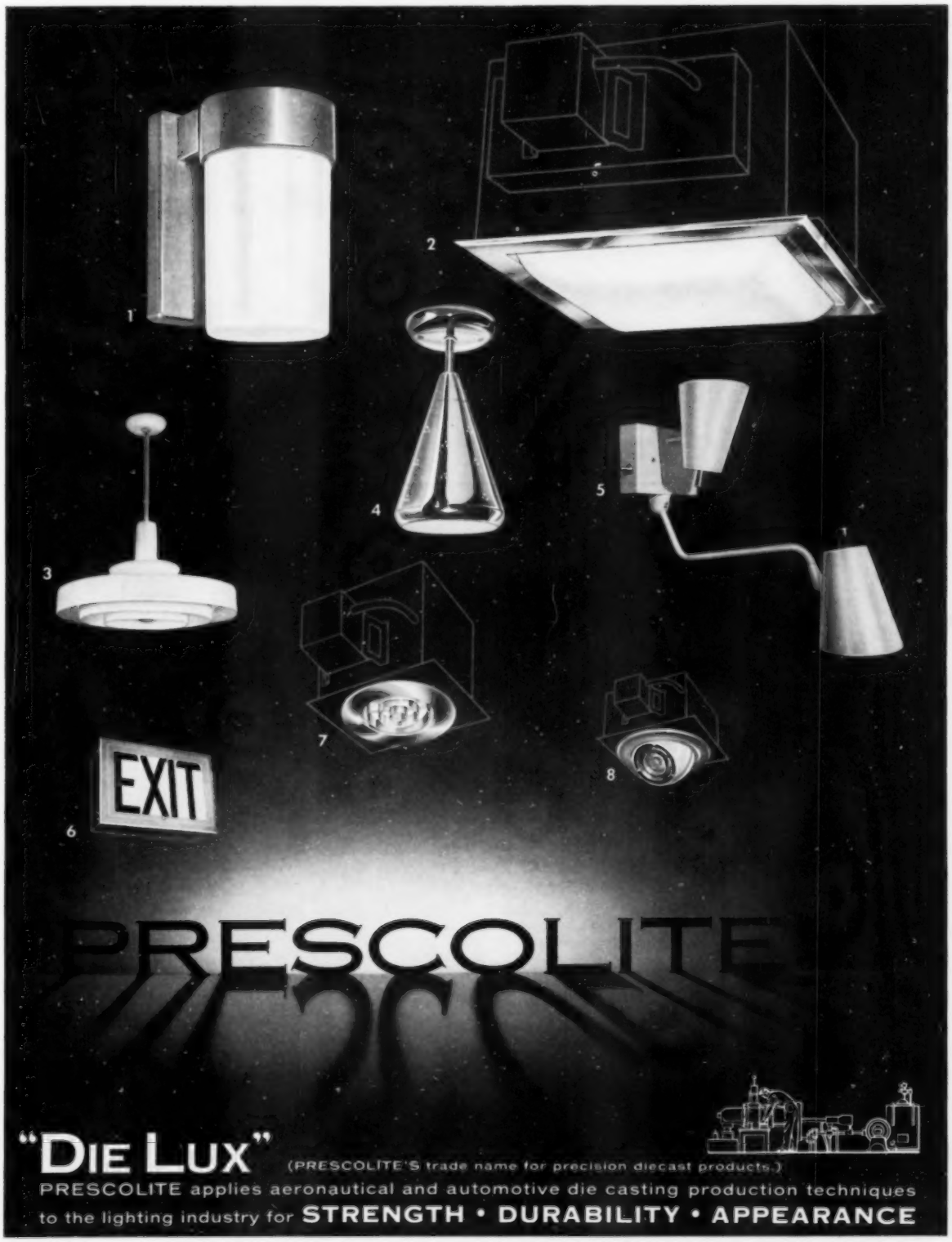

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(PRESCOLITE'S trade name for precision diecast products.)

PRESCOLITE applies aeronautical and automotive die casting production techniques to the lighting industry for **STRENGTH • DURABILITY • APPEARANCE**

The fixtures illustrated above, and many more too, employ "DieLux" die castings as an integral part of the unit. 1. No. WB-24 Wall Unit. 2. No. 1313-6630 Recessed. 3. No. 500 Ring Fixture. 4. A-14 Swivel Unit. 5. No. 8585 Hospital Light. 6. No. R-54 Exit Light. 7. No. 750 Recessed. 8. No. 99 Eyeball Unit.

Write for your copies of the following PRESCOLITE literature: No. 9 (Recessed and Surface Fixtures), No. EX-1 (Exit Lights), No. LL-1 (Louver Lights), No. HD-1 (Swivel Lights), No. AE-3 (Drawings and Specs.)

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This is one of many installations in which the METCO reputation for controlled quality, sound engineering, and lighting efficiency has been recognized by leading architects, engineers and electrical contractors.

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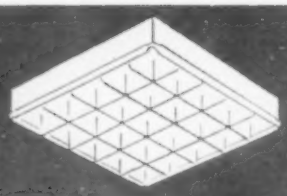


can do the job so well . . .

When it comes to Low brightness, large area light sources . . .

because . . .

LUVE-TILE in the long run is the most economical illuminated ceiling you can buy.

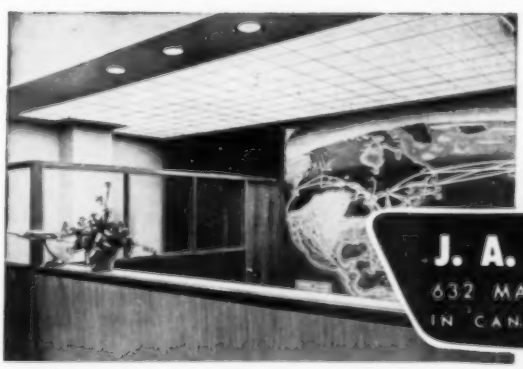
LUVE-TILE is easy to maintain—dirt collection is much less rapid than with other types . . . and it will not hold insects and other small matter.

LUVE-TILE is hinged, servicing of fixtures is easy. Rigid to handle, and light in weight, it is simple to remove and wash.

LUVE-TILE may be assembled to suit any room and custom-made work is never necessary. No unsightly horizontal bars or rosettes are used for support.

LUVE-TILE comes in 4 shades making possible unlimited colour combinations. Sprinklers and air ducts are concealed and wiring and other work may be simply surface mounted. Also low cost acoustic material may be sprayed on the cavity above the tile for sound proofing.

LUVE-TILE is practical and economical to use in any area, right down to a few square feet. It is also widely used in display for special effects.



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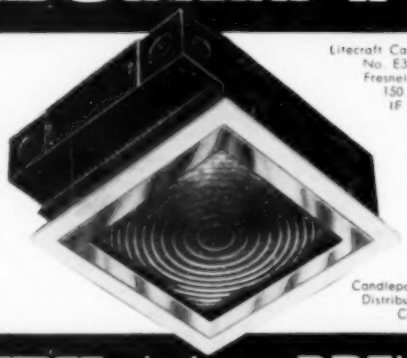
Another Big Reason Why Architects and Engineers Specify More and More LITECRAFT

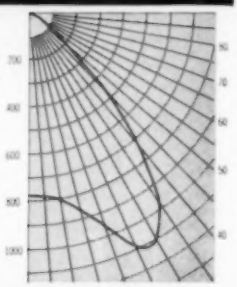
78% Efficiency

the most efficient controlled downlight ever engineered*

*Electrical Testing Laboratories Report No. 39920, on Litecraft Catalog No. E302-12 with Fresnel lens and 150 Watt IF lamp.



Litecraft Catalog No. E302-12 Fresnel Lens 150 Watt IF Lamp



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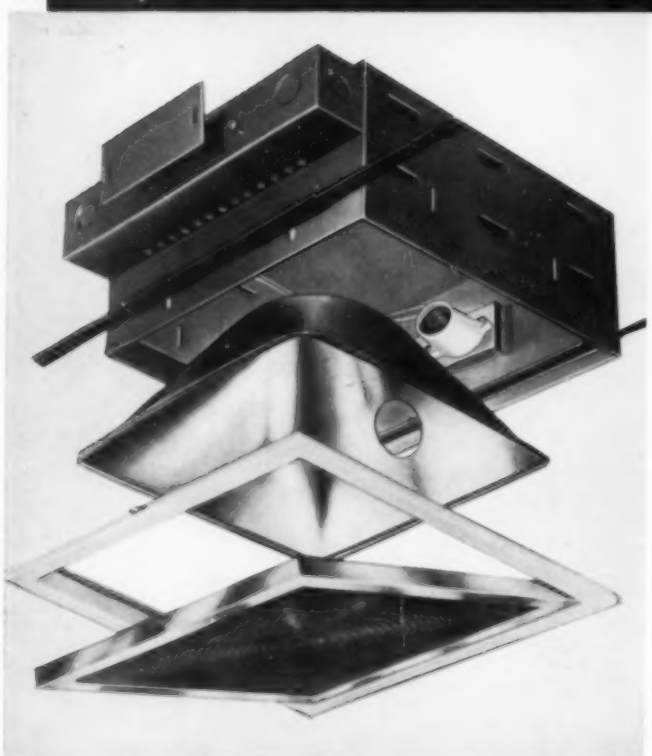
LITECRAFT de luxe PREWIRED . . . with the most efficient optical train ever devised



Underwriters' Laboratories Approved in All Sizes. Union Wired by IBEW-AFL

78% is the highest efficiency rating ever recorded for a controlled incandescent downlight unit. This outstanding achievement is even more impressive when evaluated in terms of the dollars and cents savings it assures all along the line:

- **Fewer Units Needed**
- **Shorter Installation Time**
- **Lower Power Load**
- **Fewer Lamps to Buy or Replace**
- **Less Maintenance Time**

LITECRAFT-ENGINEERED *PLUS* FEATURES:

Unique Versatility

Wide choice of sizes, shapes, wattages, finishes and shieldings . . . standard squares, rectangular and a square to replace one 12" ceiling tile.

Wide Applications

Adaptable for poured concrete and psychiatric applications or nitelite circuit . . . available with top access, wire guards and special finishes.

Easiest Fixture to Connect

Inner and outer access plates and six knockouts assure easy entry into wiring compartment through sides, top or end. UL Approved for use with lowest cost wire (R, T, TW, etc.) No asbestos wire needed.

In addition, Prewired Litecrafts incorporate design features that make them the simplest to install, the coolest operating units ever engineered, and the easiest to relamp and maintain.

For more detailed information, write for Litecraft Architectural Bulletin 556E, or consult your Litecraft Field Engineer. He'll furnish you with a complete Litecraft Architectural File — registered in your name — of engineered lighting designs for every type of application.

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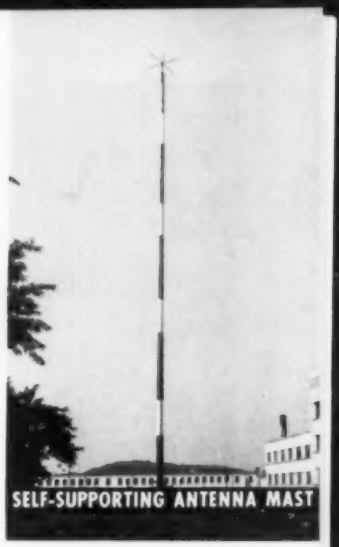

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50 years of experience in pole design and manufacture

SUPERIOR strength . . . attractive appearance . . . broadest line of designs . . . unmatched experience in pole construction. Four all-important features that make Monotube poles *your best buy* for every outdoor need.

For complete-line catalogs or helpful advisory service, write to The Union Metal Manufacturing Company, Canton 5, Ohio.

Congratulations to the IES on fifty years of lighting-engineering progress.

1906 *Fiftieth Anniversary* 1956

UNION METAL

Monotube Poles

Now!

NO VISIBLE TRIM
in kurt versen's
NEW Radix!

This newest fixture simplifies the problem of maintaining an unbroken ceiling line.

- *no visible trim on ceiling*— a perfectly smooth ceiling, without special plastering or handling.
- *practically invisible light source*— dramatic lighting effects, at maximum efficiency.
- *baffled down-light* or adjustable beam models available for widest applications.
- *top or bottom servicing*— standard on all units, with maximum ease of replacing lamps.
- *all electrical work at one time*— cuts installation costs in half, because of kurt versen cost-reducing detachable yoke construction and no-frame* installation.

For the latest improvements in lighting design, always refer to kurt versen fixtures...they look better, work better, last longer.

kurt versen company
englewood, new jersey 25
contemporary lighting creatively engineered

*U.S. Patent 2,456,903; 2,614,785; other pats. pend.

(*Continued from page* 31A)

Sections and Chapters of I.E.S. report with sorrow the deaths of these members:
John H. Fatz, Philadelphia Section
William B. Johnston, Alamo Chapter
Karl M. Koch, Golden Gate Section
Benjamin A. Lerten, Philadelphia Section
Russell L. Lothamer, Cleveland Section
John B. Merrill, Eastern Pennsylvania Section
Marshall D. Nutt, New York Section
C. T. Siebs, New York Section

ABOUT PEOPLE

Caroline Horn, by action of the I.E.S. Council last month, became the first woman to be elected a Member Emeritus of the Society. Miss Horn, a past-chairman of the New York Section and long an active Member of I.E.S., retired two years ago from the Electrical Testing Laboratories.

Charles L. Amick has been appointed to the newly created position of Central Regional Sales Manager for Day-Brite Lighting Inc. He will have his offices at the company's headquarters at 5411 Bulwer Ave., St. Louis, Mo. Prior to this appointment, Mr. Amick held the position of illuminating engineer in the Lamp Division of General Electric Co. A Fellow of I.E.S., he was general chairman of the 1955 Conference Committee for the Cleveland Conference last September.

Dr. Jesse E. Hobson, director of the Stanford Research Institute since March 1948, has submitted his resignation effective next March 31. This resignation was prompted by reasons of his personal health.

The Harry F. Wilson Associates, Inc., a Missouri corporation with offices at 4908 Delmar Blvd., St. Louis, Mo. has been formed and duly incorporated as a professional consulting engineer organization. Officers and directors of the new corporation are: **Harry F. Wilson,** Chairman of the Board; **George F. Herold,** President; **Thomas F. Delaney, Jr.,** Vice-President and Secretary; and **Charles H. Seldon,** Vice-President and Treasurer.

William J. Klaus has been named Manager of Midwest Sales Division of Crouse-Hinds Co., filling the post left vacant by the late **E. Nathan Jolliff.** His divisional territory includes North Texas, New Mexico, Colorado, Wyoming and Oklahoma, with headquarters in Tulsa. Succeeding him as Regional Manager of the St. Louis Region, Central Division is **F. W. Oberle.**

(*Continued on page* 78A)

Certified Lighting for a Better America

ELECTRICAL CONTRACTORS, WHOLESALERS, LIGHT & POWER COMPANIES!

This program is sponsored by all these member companies of the Industrial and Commercial Lighting Equipment Section of the National Electrical Manufacturers Association to help you increase your sales.

These manufacturers stand ready collectively and individually to cooperate with you in every possible way to help you get the most out of this CERTIFIED LIGHTING PROGRAM. Call on them!

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Solar Light Mfg. Co.
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New... Easier Way to Sell Bigger Profit Lighting Jobs!

Guarantee Satisfaction By Having Your Lighting Plan Certified to Meet NATIONAL STANDARDS

Now you can get the 3 business-clinching sales tools you've always wished you had to sell more lighting jobs! (1) Now you've got a tested way to prove to customers that you can and will deliver the kind of lighting they need. You've got a CERTIFIED Lighting Plan to back you up. It's the best way yet developed to keep customers from being tempted into buying sub-standard jobs because of price! (2) You've got the PLUS FEATURES Check List to sell MORE QUALITY into the job and get a bigger order, too! (3) You've the certificate issued by a disinterested authority countersigned by you, to back up your selling of proper illumination. Get all the facts... write for free booklet.

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This program is operated locally under the joint sponsorship of all electrical groups. If your area is listed below, get in touch with your local group... otherwise, write National Lighting Bureau.

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Certified Lighting for a Better America

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Certified Lighting

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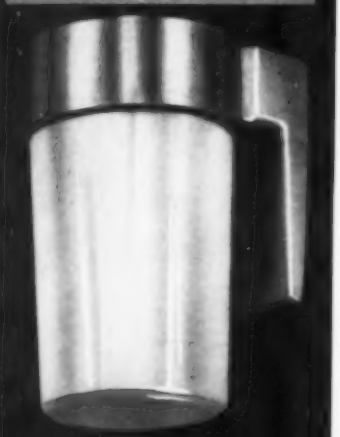

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dynamically new . . . obsoletes all old wall brackets!

A modern building with yesterday's fixtures is like a lovely woman wearing last year's hat. McPhilben's new multi-use wall bracket the '43-40 series is beautifully honest in design . . . of rugged, no maintenance-needed, die cast aluminum vaportight, versatile and competitively priced.

APPLICATIONS: Stair landings, Corridors, Lavatories and Entrances, Schools, Hospitals, Office buildings and Housing.

SPECIFICATIONS: 43-40 VT, die cast aluminum, satin finish anodized, quickly mounts to 4" cast iron junction box . . . for indoor application suitable for standard outlet box. **WATTAGE:** Maximum 100 watt — Globe: Threaded opal with gasket. Write for Data Sheet on complete VAPORTIGHT SERIES.

DIE CAST PROTECTIVE GUARD AVAILABLE (43-44VT) for locations where protection against theft and vandalism is essential. Also available as a ceiling fixture.

1353 Willoughby Ave., Brooklyn 37, N.Y.

CONSULT mcPhilben Lighting SPECIFY

Representatives in major cities
Stocked By Electrical Wholesalers

(Continued from page 76A)

The Board of Directors of the Edison Electric Institute have selected **Edwin Vennard** for the office of Vice-President and Managing Director of the Institute to become effective upon the retirement of **Colonel Howard S. Bennion** on June 1. Mr. Vennard will join the Institute on or about March 1 as a Vice-President. Mr. Vennard has been President of the Middle West Service Co., Chicago since 1953 and prior to that he was with the General Electric Co. Testing Department, the Gulf States Utilities Co. and the Southwestern Gas and Electric Co.

The appointment of **Albert Hansen, Jr.,** as manager of engineering for General Electric's Rectifier Department has been announced. Mr. Hansen was formerly manager of advanced engineering for the company's Instrument Department.

J. W. Corey, president of the Reliance Electric & Engineering Co., Cleveland, Ohio, was elected president of the National Electrical Manufacturers Association by the NEMA Board of Governors, last November. Mr. Corey succeeds **Albert F. Metz,** chairman of the board and chief executive officer of the Okonite Co., Passaic, N. J. Other officers elected are: Vice-Presidents: **F. F. Loock,** Allen-Bradley Co. Milwaukee, Wis.; **J. J. Mullen, Jr.,** Moloney Electric Co., St. Louis, Mo.; **B. C. Neece,** Landers, Frary & Clark, New Britain, Conn.; **W. V. O'Brien,** Apparatus Sales, General Electric Co., New York, N. Y.; and **J. L. Singleton,** Allis Chalmers Manufacturing Co., Milwaukee, Wis. **Arthur A. Berard,** Ward Leonard Electric Co., Mount Vernon, N. Y. was elected Treasurer.

At the annual November meeting of the RLM Standards Institute, **W. P. Lowell, Jr.,** Sylvania Electric Products, Inc., was elected Vice-President to fill the vacancy created by the death of **Alden Barnes,** one of the founders of the Institute. Action was also taken to increase the Board of Trustees from five to seven members: the new board to consist of **Hoyt P. Steele,** Benjamin Electric Mfg. Co., President; **W. P. Lowell, Jr.,** Vice-President; **Edward C. Huerkamp,** Westinghouse Electric Corp., Treasurer; **Burton G. Tremaine, Jr.,** The Miller Co., Secretary; **James F. Whitehead, Jr.,** Day-Brite Lighting, Inc., Chairman of Technical Committee; **D. E. Worrell,** Quadrangle Mfg. Co.; and **Leonard A. Hobbs,** Smoot-Holman Co.

The elevation of **J. H. Fall III** to the post of Vice-President in Charge of

(Continued on page 80A)

Free

New

Alkco

ENGINEERS HANDBOOK

"Custom Lighting"

This new handbook contains examples of fixtures designed to solve particular lighting problems. You'll find details of recessed, surface mounted, and wall mounted fixtures—incandescent and fluorescent.

ALKCO offers you design and engineering assistance on custom lighting. Let us help you solve problems such as shallow concrete slab installations, beam mounting, low ceilings, limited headroom and many others.

Our reputation for custom fixtures has been established by installations in executive offices . . . exclusive stores . . . schools . . . hospitals . . . fine homes. If you want custom lighting priced within the range of standard fixtures, rely on **ALKCO.**

Write for your new ALKCO Engineers Handbook "Custom Lighting."

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Outstanding National manufacturer of commercial and industrial fluorescent lighting fixtures seeks the services of an individual with experience capable of developing creative ideas. To work directly under Design Director of company.

Situated in Boston area.

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Seek two experienced commission salesmen with ambition, drive, and yen to make more money. Should be well-versed in all phases of the lighting field . . . engineering or technical background helpful. Must be calling on architects, engineers, distributors and contractors . . . in the MINNESOTA, NORTH & SOUTH DAKOTA, or the UPPER NEW YORK STATE territories.

We are a large progressive and growing manufacturer of complete lines of competitively priced lighting for all applications. Our quality and service are now active and profitable. . . We are being specified and displayed. . . Our men get powerful promotional backing. These openings are due to a long-range expansion of our facilities, lines and promotional programs. Send full details to: Box 260, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N.Y.

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High earning power, planned national advertising and live leads waiting for qualified appointee.

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NO. 6163 — 24" Diameter (left)
Wired for four 100W lamps plus a 500W R-40 floodlamp for concentrated downlighting thru the louver bottom.

NO. 6181 — 12" Diam. Cylinder (right)
Wired for three 100W lamps plus a 500W R-40 floodlamp for concentrated downlighting thru the louver bottom.

New distinctively styled designs provide high intensity glare-free illumination, while adding charm and beauty to church or public building. Special design service available. Write for new illustrated catalogs.

the creative beauty of Lighting by Novelty

NO. 6152 — 24" Top Gallery
Wired for seven 100W lamps plus a 500W R-40 floodlamp for concentrated downlighting thru the louver bottom.

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Fine exterior lighting of all copper and bronze material . . . designed in standard bronze or satin pewter finish to match aluminum or stainless steel building trim.

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Designers and Manufacturers . . . Since 1905

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(Continued from page 78A)

Sales for the Benjamin Electric Manufacturing Co., has been announced. Mr. Fall has also made known the appointments of **A. E. Swedenborg** as General Sales Manager and **Robert J. Mors** as Assistant Sales Manager. The company's Board of Directors have also announced the election of **George A. Hamm** as Vice-President in Charge of Finance, and **A. H. Franking** as Controller. Mr. Hamm was formerly Controller and Mr. Franking Assistant Controller.

The purchase of Salem Brothers, Inc., Linden, N. J., has been announced by **Ben Roisman,** President of Litecraft Manufacturing Co., New York City. Litecraft's plans for Salem Brothers, which will retain its identity as a division of the parent company, include a long-range expansion program under the direction of **Edwin R. Manning,** Litecraft's vice-president in charge of sales.

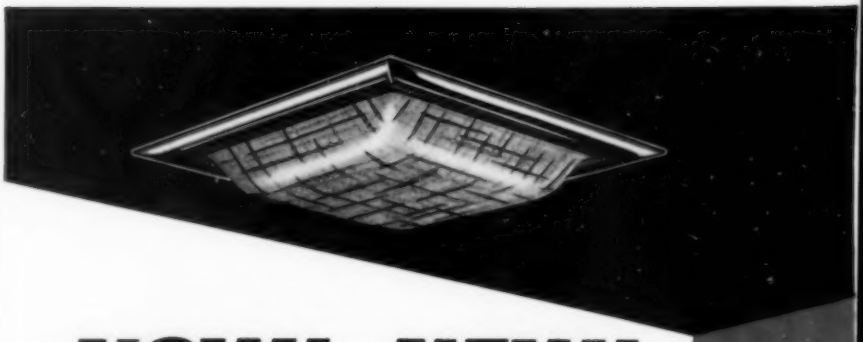
Richard C. Schey has been appointed manager of General Electric's Construction Materials Northwestern District succeeding **William W. Bryan,** who has been transferred to the Division's Pacific District in Los Angeles as manager. Mr. Schey's office and headquarters will be located at 220 Dawson St., Seattle.

Charles B. Swann has been appointed as the direct factory representative for the New England territory of the Pittsburgh Reflector Co. From headquarters in Marshfield, Mass., he will coordinate fluorescent and incandescent lighting equipment engineering, sales and service.

BOOKS AND PAMPHLETS

ASTM Standards on Plastics (D-20), published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. October 1955. 790 pages, paper bound, $5.75.

This compilation presents the ASTM standards and tentative specifications, methods of physical testing, recommended practices and definitions of terms pertaining to plastics. It is a revised edition of the previous volume published in May 1954. Of the total of 143 specifications and tests four are entirely new and 41 have been either revised, reaffirmed or advanced from tentative status to standard. The standards have been developed by the ASTM Committee D-20 on Plastics.



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The Engineering Societies Directory, a complete list of all engineering societies in the United States, together with pertinent information about them, will be published by the Engineers Joint Council tentatively as of June 1, 1956. The Directory will be a new publication, not a revision of the Engineering Societies Yearbook, which was published in 1948, and which has been discontinued. The Directory will be the only complete listing of engineering societies at all levels and will be available at $3.50 per copy.

Wide-Screen Motion Pictures, a brief booklet describing the several new methods of motion picture production and exhibition that have come into use during and after 1952, has been published by the Society of Motion Picture and Television Engineers. The 12-page booklet is aimed at giving a comprehensive, yet easily understood outline of present-day techniques and the ways in which they differ from those "standard" during the late nineteen twenties. The booklet makes no attempt to evaluate systems. Copies are available from SMPTE headquarters at 55 West 42nd St., New York 36, N. Y.

400 American Standards in the Electrical Field is a 60-page booklet which indexes and describes each American Standard in the electrical engineering area. It is designed to help the user and prospective purchaser to find the applicable standard on the product in which he is interested. The booklet also gives briefs of each of the current International Electrotechnical Commission recommendations; a listing of all projects under the jurisdiction of the Electrical Standards Board. The booklet may be obtained from the American Standards Association, 70 East 45th St., New York 17, N. Y.

NEW MEMBERS

At the meeting of the I.E.S. Council held at New York, N. Y. on December 8, 1955, the following were elected to membership. Names marked * are transfers from Associate Member grade.

ARKANSAS CHAPTER

Associate Members:

Keathley, L. C., Arkansas Electric Co., Little Rock, Ark.

Magruder, C. T., General Electric Supply Co., Little Rock, Ark.

BLUENOSE CHAPTER

Associate Members:

Saxton, D. F., 17 Birmingham St., Halifax, N. S.

Smith, F. E., Carter & Smith Ltd., Halifax, N. S.

BRITISH COLUMBIA SECTION

Associate Member:

Clay, R. E., B. C. Engineering Co. Ltd., Vancouver, B. C.

CAPITAL SECTION

Associate Member:

Feak, E. D., Southern Railway, Washington, D. C.

CENTRAL ILLINOIS CHAPTER

Associate Member:

Kamlager, H. A., Kamlager Electric Co., Canton, Ill.

CENTRAL NEW YORK SECTION

Associate Members:

Bills, F. S., Jr., N. Y. State Electric & Gas Corp., Auburn, N. Y.

Mulcahy, J. P. J., N. Y. State Electric & Gas Corp., Ithaca, N. Y.

Waverchak, B. C., Galson & Galson, Syracuse, N. Y.

CHICAGO SECTION

Associate Members:

Buehring, L. E., Domestic Engineering Co., Chicago, Ill.

Gordon, L. M., Gordon Electric Supply, Kankakee, Ill.

Klos, E. H., Skidmore, Owings & Merrill, Chicago, Ill.

Marinello, R. L., Technical Publishing Co., Chicago, Ill.

Moran, B. G., Mitchell Mfg. Co., Chicago, Ill.

(Continued on page 82A)

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- "Luxury Lenses" for dramatically effective interior and exterior commercial and residential lighting!
- Famed "Strato-Ray Lens" with Alzak reflector — the only recessed lighting fixture that bends light up and across ceiling and illuminates floor area with no glare in approach areas!
- Plus "ROOM RATING" to assure performance proven lighting — the quicker, practical way!

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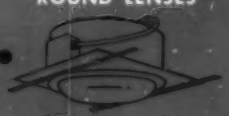

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1 they are drawn from *heavy-gauge* steel
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9513—24" dia., 30" length, brushed brass and black with white glass—or to custom specifications.

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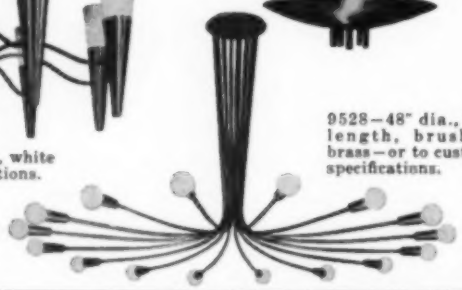

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(Continued from page 81A)

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Spencer, K. C., Corning Glass Works, Chicago, Ill.
Walther, R. W., Mason & Basedow, Chicago, Ill.
Wienick, P. P., Mitchell Mfg. Co., Chicago, Ill.

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Connecticut Section

Member:

Millington, H. J., The Miller Co., Meriden, Conn.

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White, F. G., Niagara Mohawk Power Corp., Canajoharie, N. Y.

Associate Members:

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Mason, J. E., Raybro Electric Supplies, Inc., Tampa, Fla.
Rollick, C. T., Thomas Industries Inc., Louisville, Ky.

Golden Gate Section

Associate Members:

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Cochran, H. R., Foster & Kleiser Co., San Francisco, Calif.
Colman, R. E., Incandescent Supply Co., San Francisco, Calif.
Holzer, Richard, Schay & Holzer Architects, Panama City, Republic of Panama.
Kofka, J. F., 1200 Washington St., San Francisco, Calif.
Krivanek, J. T., Jr., National Electrical Contractors Assoc., Oakland, Calif.
Newland, William, Incandescent Supply Co., San Francisco, Calif.
Virgil, Russell, San Francisco Lighting & Supply Co., San Francisco, Calif.
Wilson, W. W., Prescolite Corp., Berkeley, Calif.
Wolfe, J. W., North Bay Electric Works Inc., San Rafael, Calif.
Wong, H. K., Ceplo, Inc., San Francisco, Calif.

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Associate Members:

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Hucaluk, Fred, Public Utilities Commission of Galt, Galt, Ont.
Knapp, A. C., Amalgamated Electric Corp. Ltd., Ancaster, Ont.

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*Schnitker, N. F., Indianapolis Power & Light Co., Indianapolis, Ind.

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McClellan, J. A., Southern College of Optometry, Memphis, Tenn.
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*Young, J. W., New England Power Service Co., Boston, Mass.

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(*Continued on page* 85A)

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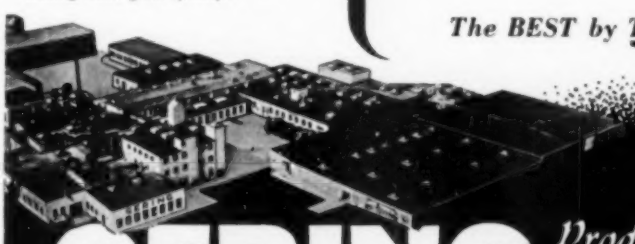

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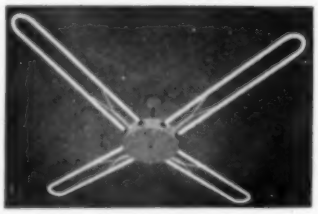

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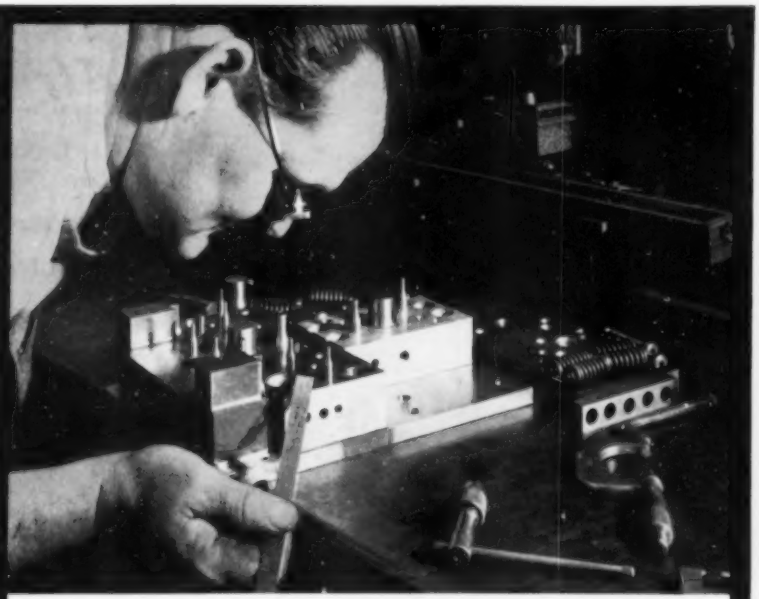

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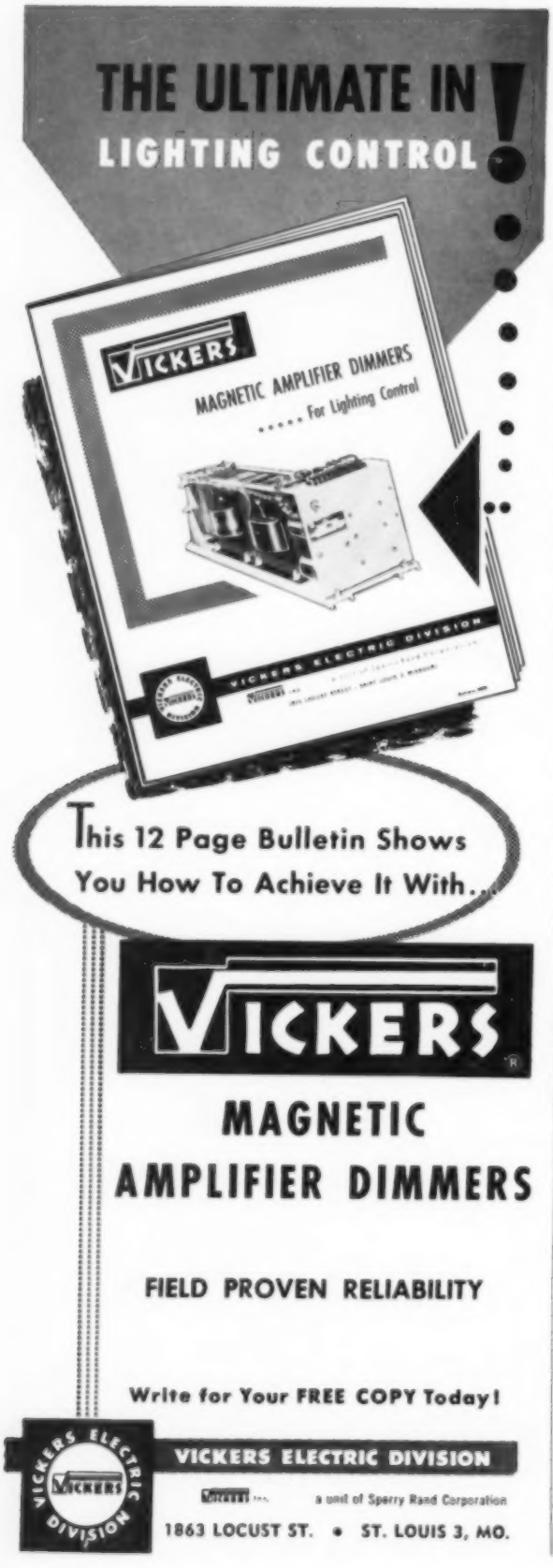

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HIGH hiding power of Sheffield DG-70 plastic shield (on left) is contrasted with shield of regular styrene (on right). Shields have equal light transmission.

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Sheffield's new DG-70 polystyrene shields have higher hiding power and higher light transmission (up to 50%) than regular styrene shields. The lighting efficiency of plastic-shielded troffer units can thus be increased without sacrifice of their soft, even, glare-free, lighting qualities.

DG-70 shields not only make possible higher efficiency ratings, for present fixtures — without expensive design changes — but, because of the possible variations in light transmission and hiding power, create opportunities for entirely new designs. They are another example of Sheffield engineering leadership in the design and manufacture of rigid plastic extrusions.

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Sola Ballasts for 100w rapid-start lamps incorporate many exclusive design and manufacturing features that result in premium ballast performance, and for many years commanded a premium price over other ballasts. Now, you get traditional Sola premium quality at no additional cost when Sola Ballasts are part of your indoor or outdoor rapid-start lighting installations.

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OUTDOOR HIGH-OUTPUT RAPID-START BALLAST

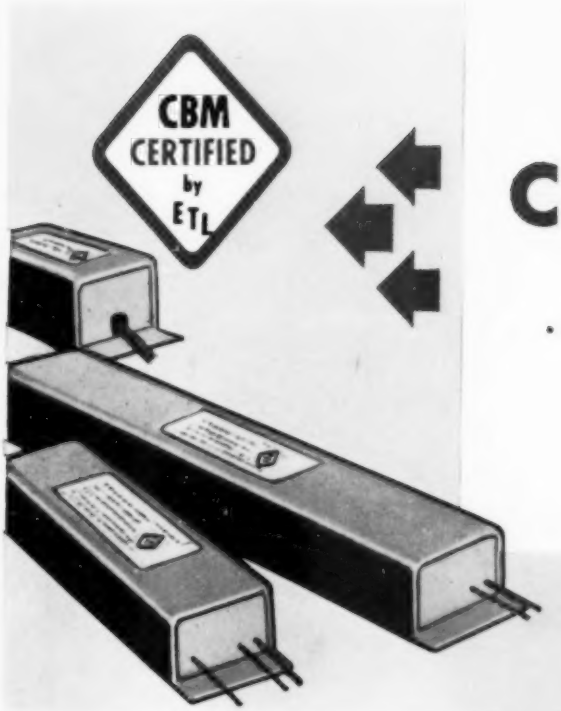
OUTDOOR 100W RAPID-START BALLAST: *The Sola unit (Cat. No 626-920) shown above provides efficient and economical two-lamp operation with outdoor 100w 72T12, rapid-start lamps. Electrical specifications are: lamp current, 1000 ma; nominal circuit voltage, 118; ballast wattage loss, 40; series-type circuit. For applications where ambient temperatures as low as −20° F. are encountered, particularly for street lighting and in parking lots and gasoline stations.*

INDOOR 100W RAPID-START BALLAST: *The Sola Ballast (Cat. No. 628-819) below is for operation of two 100w, 96T12 rapid-start lamps. Electrical specifications of this unit are: lamp current, 800 ma; nominal circuit voltage, 118; ballast wattage loss, 35; series-type circuit. It complies with proposed CBM ballast specifications and is ideal for indoor industrial applications where high-intensity fluorescent lighting is desirable.*

INDOOR HIGH-OUTPUT RAPID-START BALLAST

SOLA *Fluorescent* **BALLASTS**

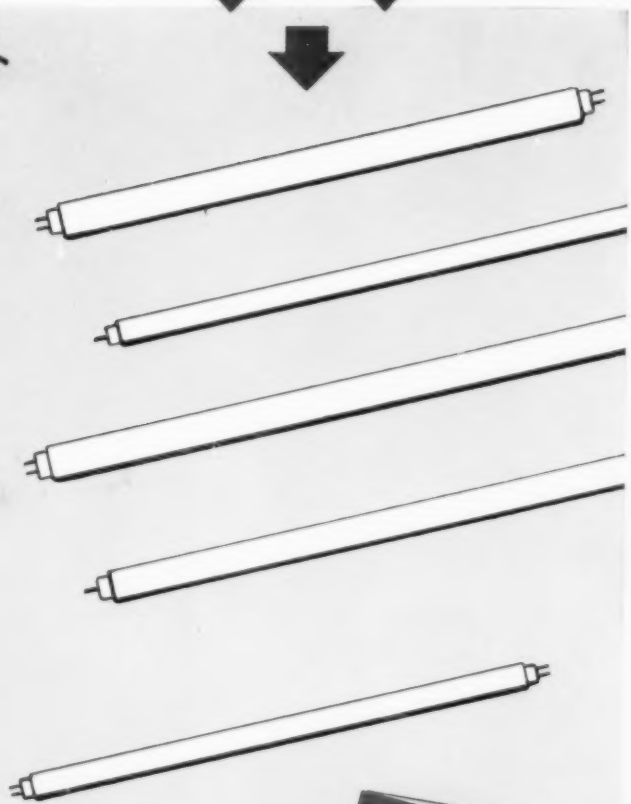
CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464* • *PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988* • *BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354* • *CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400* • *KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382* • *LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431* • *TORONTO 9, ONTARIO: 617 Runnymede Rd., RO 7-1654* • *Representatives in Other Principal Cities*



CERTIFIED CBM BALLASTS

...give you more economical Fluorescent Lighting

because they are "Tailored to the Tube"



Every type and size of fluorescent tube has its own specific electrical requirements. Thus, to get ideal performance and lighting economy, it is essential that the ballasts provide precisely the electrical needs of the tubes they operate.

CERTIFIED CBM BALLASTS are "Tailored to the Tube." Built to exacting specifications, then tested and checked by ETL, an independent agency, CERTIFIED CBM BALLASTS are a dependable assurance of both satisfactory and economical fluorescent lighting.

Certified CBM Ballasts

PROVIDE:

LONG BALLAST LIFE
FULL LIGHT OUTPUT
LONG LAMP LIFE
TROUBLE-FREE OPERATION

all of which contribute to easier maintenance and fluorescent lighting economy.

Eight of the country's leading manufacturers of ballasts make CERTIFIED CBM BALLASTS. Participation in CBM is open to any manufacturer who wishes to qualify.

Send for free booklet, "Why It Pays to Use CERTIFIED CBM BALLASTS in Fluorescent Lighting Fixtures."

CERTIFIED BALLAST MANUFACTURERS
2116 KEITH BLDG., CLEVELAND 15, OHIO

50

Guth

I·E·S

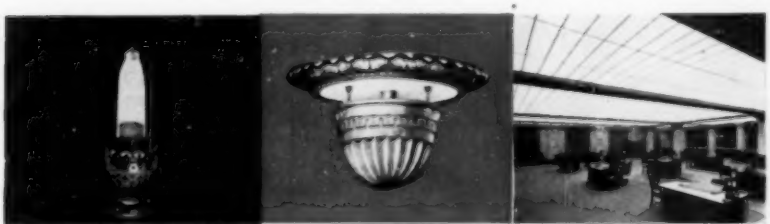
side by side for 50 golden years ...

WORKING TOGETHER FOR BETTER LIGHTING

We at Guth are grateful to have enjoyed the privilege of working with I.E.S. *since its beginning.*

During this past half century, we have found many times in I.E.S. the inspiration to spur us on to higher goals and greater achievements in lighting.

Now, we are looking forward to the next 50 GOLDEN YEARS. We know they will be even brighter.



FROM GASLIGHT TO BRASCOLITE TO GRATELITE *

THE EDWIN F. Guth COMPANY, ST. LOUIS 3, MISSOURI

TRUSTED NAME IN LIGHTING SINCE 1902

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